THE MONTHLY

Review

Sh..h..h.. Coming Soon
Details About

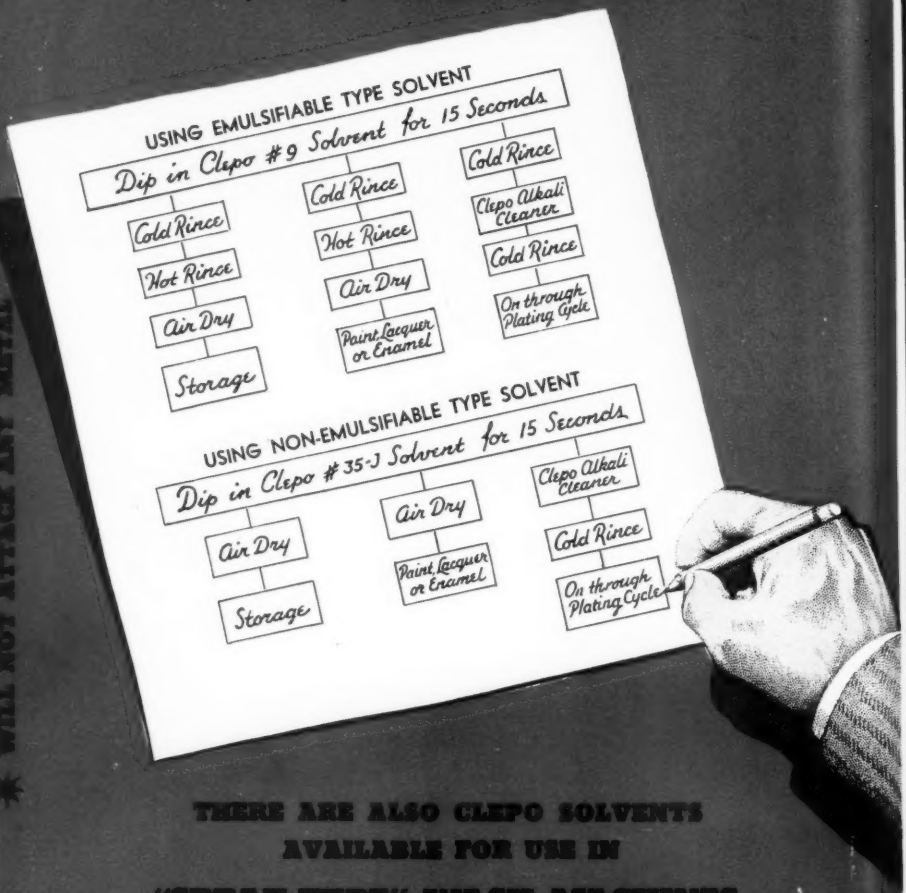
The Hall Of Platers' Contribution
To The WAR Effort

Official Organ of the American Electroplaters' Society
A Society for the Advancement of the Science of Electroplating

OCTOBER ✦ ✦ ✦ 1945

CLEPO SOLVENTS
FOR ALL CLEANING PURPOSES!

FOR ALUMINUM, BRASS, BRONZE, COPPER, STEEL, IRON, ZINC AND ALL ALLOYS.



WILL NOT ATTACK ANY METAL

THERE ARE ALSO CLEPO SOLVENTS AVAILABLE FOR USE IN

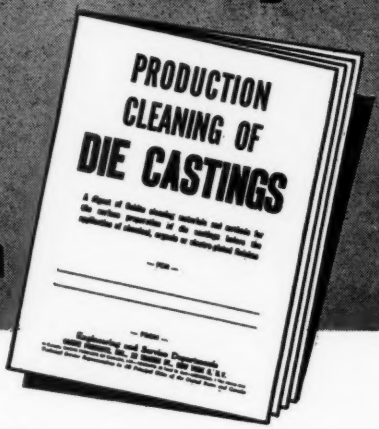
"SPRAY-TYPE" WASH MACHINES

CLEPO — CLEANING COMPOUNDS

FREDERICK **GUMM** *Chemical Company Inc.*

538 FOREST STREET, KEARNY, N. J.

Send For This *FREE* Digest on Oakite Surface Preparation



DIE CASTINGS that are to receive organic, chemical or plated finishes for protective purposes or sales appeal must be FIRST thoroughly cleaned. This newly-published Oakite Digest, "Production Cleaning of Die Castings" gives you valuable data on low-cost surface preparation methods based on the successful experience of hundreds of producers and users of die castings.

Aluminum, zinc, magnesium, brass, bronze . . . practically every alloy and the techniques and Oakite materials employed in cleaning or related operations on die cast parts are fully discussed so that you can make comparisons with your present methods or find a new answer to some surface preparation problem now confronting you.

Free Copy on Request

Because it can save money for you, send for a copy of this fact-filled Oakite Digest today. It's yours for the asking.

OAKITE PRODUCTS, INC., 40 Thames St., NEW YORK 6, N. Y.

Technical Service Representatives in All Principal Cities of the United States and Canada

OAKITE *Buy Bonds for Victory* CLEANING

TRAPS
acid fumes
ENTHONE
ACID ADDITION AGENT
Brings surface active forces into play to form a thin foam that traps acid fumes and spray. This prevents corrosion of surrounding equipment and protects the health of workers—safeguarding expensive installations and keeping labor happy. New literature tells eight additional advantages of using Enthone Acid Addition Agent.
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THE Enthone CO.
Manufacturers
Plating Equipment and Chemicals
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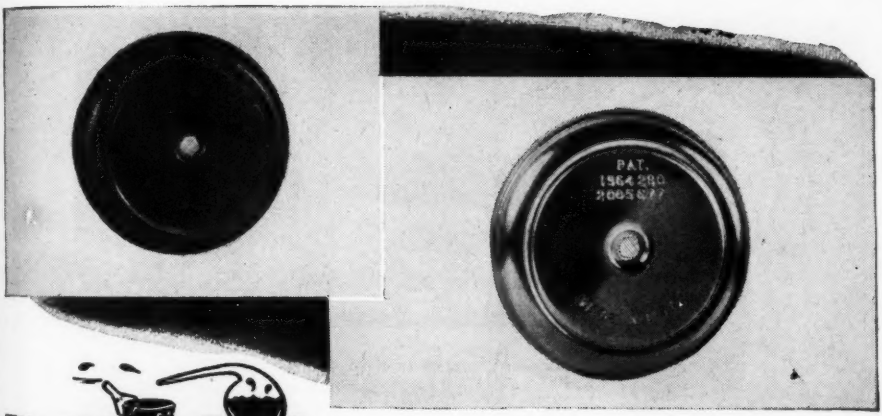

"Bright as a Silver Dollar"

. . . . and Stays that way!

Shiny, too! In short, Luster-on* bright dip for zinc-plated parts is an economical finish, available now, that gives sales appeal and a protective coating in one simple application.

Study the unretouched photograph a moment. Notice how fingermarks and white corrosion have already marred and made repulsive the ordinary zinc plating. Then see the gleaming chromium-like brilliance of the Luster-on* dipped part. No dark smudges, no age stains, no white disfigurements for Luster-on* even resists salt spray exposure!

Tools, parts and other zinc-plated articles will find their place in present and postwar markets more easily with a Luster-on* finish.

KEMO SAYS: Send us a sample of your zinc-plated items for free processing with Luster-on*. See the improvement with your own eyes.

*Patent applied for

THE Chemical CORPORATION

54 Waltham Ave., Springfield 9, Mass.

THE CHEMICAL CORPORATION
54 Waltham Ave., Springfield 9, Mass.

Please send me full particulars about Luster-on* bright dip for zinc surfaces. I am (am not) sending sample part for free dip. No obligation, of course.

Name.....

Address.....

Monthly Review — October

FREDERIC B. STEVENS INCORPORATED
EVERYTHING FOR PLATING AND POLISHING
DETROIT · 26 · MICHIGAN
What's a trademark worth . . .
EVER GIVE IT A THOUGHT?
A trademark can mean a whole lot! For example—when you see the STEVENS ELEPHANT and the slogan "EVERYTHING FOR PLATING AND POLISHING" associated with
POLISHING, BUFFING, COLORING, and DEBURRING COMPOSITIONS.
you can rest assured that it carries a two-fold guarantee of extra quality . . . laboratory control of raw materials —combined in proper percentages and tested under actual working conditions to assure the best obtainable results in your finishing operations.
There is a Stevens Composition especially developed for use on all types of mechanical or hand buffing operations —"precision" materials, exactly uniform in formula, texture and quality. For better all-around results, use a composition bearing the Stevens trademark.
GREASELESS COMPOSITIONS
(Glue Base) for
DEBURRING POLISHING BUTLER, SATIN and BRUSH FINISHING
BUFFING COMPOSITIONS
(Steric Acid Base) for
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· 2365 Dundas St. West Toronto, Ontario
BUFFING COMPOSITIONS · METAL POLISHERS AND ELECTROPLATERS SUPPLIES-EQUIPMENT

THE MONTHLY

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CONTENTS

CALDWELL — A.E.S. Research Fund — Report from Finance Sub-Committee 985

Referendum Vote on Newark Amendment 997

GLASSTONE — Part XXI 999

HENNESY AND DIMON — 1946 Convention in Pittsburgh 1002

Research Committee Meeting Report 1003

FERGUSON AND STEPHAN — A.E.S. Research Project No. 3 — Adhesion of Electrodeposits II 1006

CARLSON AND KRANE — High Speed Zinc Plating 1022

SMITH — A Miniature Laboratory Fume Eradicator 1028

SAFETY RESEARCH INSTITUTE — Care of Fire Extinguishers 1030

DEPARTMENTS

Industry News 1033
Patent Abstracts 1037
Abstract Section 1041
Branch News 1045
Membership Report 1051
New Equipment, Materials, Supplies 1055
Branch and A.E.S. Officers Directory 1061
Advertisers Index 1071

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Entered as second class matter September 14, 1945, at the post office at Paterson, N. J., under Act of August 24, 1912.

*Ventilated NON-FRAYS

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CHAMPION PIECED BUFFS

Polishing Wheels and Burring Bobs for every Operation

*Patent Nos. 2,027,863; 2,094,650; 1,573,961; Re. 19,894; 2,140,208

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CADMIUM No. 64 PROCESS
A/C COPPER. PRO-SEAL
No. 90-S and 90-B ZINC

Install the
PROMAT CADMIUM PROCESS for

NEW BRILLIANCE . . . IMPROVED COVERING POWER . . . AND SPEED

Promat cadmium process will: Increase production — Reduce rejections — Reduce floor space — Save man hours — Improve quality.

The following statement can only be made about the Promat cadmium process:

"The Promat cadmium process will deposit brilliant cadmium plate at from one ampere per square foot to 140 amperes per square foot. This extremely wide operating range allows any shaped part to be plated at sixty amperes per square foot at high efficiency of the direct current used and will, therefore, deposit at approximately one ten-thousandth inches (.0001") per minute."

The Promat cadmium process is comprised of the use of superimposed alternating upon direct current accomplished by the Promat "Kicker Unit" and the use in the electrolyte of certain Promat products.

Existing cadmium plating baths may be converted to the Promat type bath or Promat will furnish concentrated electrolyte to make up new baths.

Promat cadmium baths are maintained by the use of Promat concentrated maintenance solutions or by the use of the usual basic chemicals and small amounts of Promat addition agents.

Contact Promat Division — Poor & Company at Waukegan, Illinois, or your nearest distributor.

PROMAT KICKER

There are three lines of Promat Kicker Units: Standard to superimpose 1-6 volts AC; Intermediate 1-10 v. AC; High voltage 1-14 V AC. Control is in one-half volt steps. Remote controls as illustrated above Kicker Unit, are available for certain installations. Kicker Units may be purchased for experimental work. Promat equipment and materials are sold outright with no license or use agreement.

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Simple post-plating treatment for ZINC or CADMIUM plated parts to produce a new high lustre, improve protection, eliminate finger marking and inhibit the formation of white corrosion products on zinc.

PROMAT A/C COPPER. New fast, efficient copper plating process dependent largely on super-imposition for fine character of deposit.

PROMAT #90-S and #90-B ZINC for still, automatic, semi-automatic and barrel plating of zinc. Allows efficient use of high current densities on racked parts, improves covering power, and increases production capacity of equipment.

Write today for further information to

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You are ready for Quick Conversion to Peacetime Decorative Plating . . . . .

Choose the plating equipment you install for war work with an eye on quick conversion to peacetime decorative plating.

MEAKER Full Automatic Machines are most flexible, and can be readily adapted to handle different size racks through an entirely new sequence. Transfer mechanism may be moved or made wider, or "lift" increased at a nominal expense. Unit may be lengthened by adding new sections, without junking any considerable part of the old machine.

MEAKER Equipment is simple, compact, accessible, and oversize to stand continuous operation.

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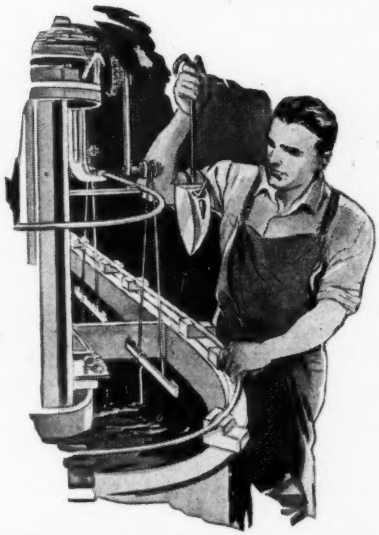
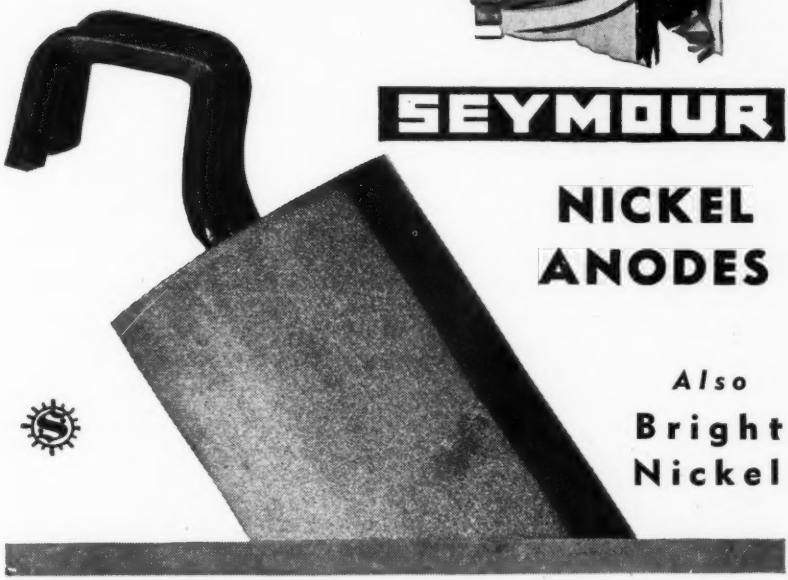
is back on the job again!

Priorities on nickel have been canceled. We can now supply nickel anodes without restriction as fast as we can produce them. Please register your needs with your plating supply source.

Seymour Nickel Anodes are made of virgin nickel, cast under accurate heat control and tested by batch to insure uniformity. Their outstanding characteristics now, as before the war, are even corrosion and uniform deposit, with loose nickel loss and sludge formation practically nil. All standard shapes, and special designs to order.





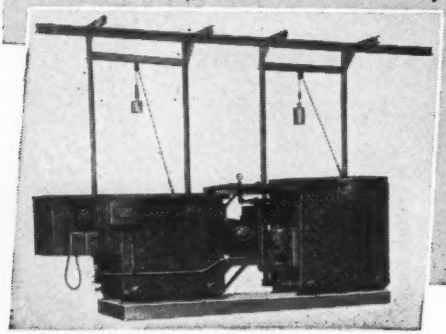
SEYMOUR

NICKEL ANODES

Also
Bright Nickel

THE SEYMOUR MANUFACTURING CO., SEYMOUR, CONN.
NONFERROUS ALLOYS SINCE 1878

A Speedier Operation with this



DIP-AGITATION and SPRAY COMBINATION

A large electrical products manufacturer had the problem of removing paint from coated racks. The OPTIMUS Dip-Agitating and Spray Units pictured above, operated in sequence, not only provided the answer, but gave a speedier operation.

The paint-coated racks are loaded in the basket and given a soak in the Dip-Agitating Unit. They are then transferred to the Spray Wash Unit where they are subjected to powerful sprays for complete removal of the loosened paint. The design keeps cleaning compartment entirely free of any obstruction, making it possible to lower a variety of objects into it quickly and simply.

In the Dip-Agitating Unit, to the soaking action in the cleaning solution is added a strong mechanical agitating action. A vertical up and down dipping motion of the load in and out of the solution speeds up the operation, handling the work in less time than normally required.

Any type of alkali, solvent or solvent-emulsion type cleaner can be used. Provision is made for temperature-controlled heating by any medium and for filtering the cleaning liquid. Adequate ventilation is provided. Overhead tracks can be used. These may be tied in with a shop track, or they can be used to pick up the load from the adjacent floor.

Easy to load, easy to heat, fast cleaning, less wearing parts, low agitation costs—these are some of the features these Units provide.

SEND FOR full details showing how these OPTIMUS Units can be adapted to these and many other applications in your plant operations.

OPTIMUS EQUIPMENT COMPANY

ENGINEERS AND MANUFACTURERS

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OPTIMUS EQUIPMENT

FOR WASHING · RINSING · PICKLING AND DRYING OF METAL PARTS

PURICO BD ANODIC CLEANER

Fast, economical reverse current compound made especially for perfect detinning prior to plating.

PURICO API

An acid inhibitor for descaling iron and steel without attack on metal. Leaves base metal clean and free from embrittlement. Easy to use and economical.

PURICO ZN BLACK

PURITAN'S improved black oxide finish for zinc. Penetrates metal and thereby cannot flake off. Produces a deep glossy black finish.

WONDERBAR

A patented Pre-Saponified Tripoli composition for cleaning and buffing intricate patterned, recessed, or filigreed metals. Its finer composition permits the thorough removal of greases and other foreign matter without manual scrubbing operations.

NOW . . . FOR POST WAR

KEEP USING RELIABLE COMPOUNDS

PURICO compounds have always been recognized and appreciated for their reliability and advanced formulae. Today as never before, the assurance to be gained that you are getting the best that money can buy is of valued importance to your metal finishing foreman.

Write us today for your copies of the PURITAN Handbook and special booklets and folders listing the many PURICO products and their various uses for the improvement of your metal cleaning and buffing cycle.

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THE Puritan MANUFACTURING COMPANY
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SESSIONS-GIFFORD CO.
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No one denies that felt polishing wheels cost more originally than some other type, but there the cost differential ends. From the operational and maintenance angles, felt wheels consistently produce finer finishes, and, because of their long life, are extremely economical.

Felt Wheels have a combination of density, resiliency and adaptability that make them ideal as to both final cost and finish for many classes of work.

Bacon Felt — manufacturers of felt products since 1824 and pioneers in manufacture of felt wheels and bobs — offers a line of felt wheels that has nine different degrees of hardness and comes in many sizes and thicknesses.

Ask your supplier for PARAMOUNT Brand Wheels and Tabs and you will get Bacon Felt Products.

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"America's Oldest Felt Manufacturers"

Winchester, Mass. **Established 1824**

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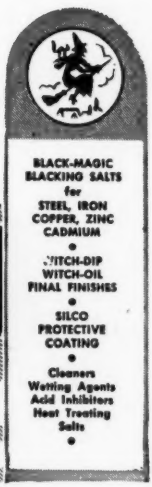
For STEEL and BRASS

Extremely tough. Remarkably beautiful. Soft matte and eggshell gloss finishes in all colors. The ideal finish for stoves, heaters, mufflers, exhaust and tail pipes, metal filing cases, etc. It withstands heat up to 1000° F. Has high resistance to corrosion, abrasion and impact.

Very easy to work. Spray it on and dry it at 200° F. Then bake it at 350° F. in any industrial oven. Ample Navy and other approvals prove that it's here to stay. Samples and full details on request. When writing, tell us what your problem is.



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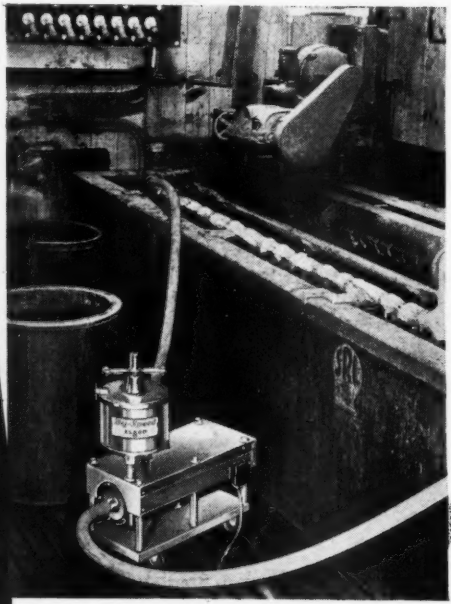
The FILTER that Plating Shop Men Are Buying... ...ON ITS REPUTATION



YOU don't have to be sold on the necessity of operating the plating bath with a clean solution. It's a "must" for any shop where the objective is high quality work at the lowest possible cost.

Investigate the merits of the ALSOP "Sealed-Disc" Filter for this work. Each disc is a separate filtering element in itself, thus providing exceptionally large filter area and high capacity. High efficiency in removing solid impurities results from the graded density of the packed fibers. The layers graduate from loose-packed to close-packed. No filter aid is necessary. The filter is easily cleaned with no loss of solution.

The ALSOP "Sealed-Disc" Filter comes in many sizes, portable or stationary. In writing for information give your bath cleaning requirements. We'll be glad to recommend the proper type and size.

ALSOP *Engineering Corp.*

35 GRAND STREET

MILLDALE, CONNECTICUT

V-J Day marked the start of reconversion—and the release of DURANITE from its three-year confinement in war work. Both facts are of vital concern to you, for DURANITE—the high-speed production finish—simplifies your reconversion problem in finishes and it's available now for every end use.

• DURANITE gives you real help in reconversion by its high-speed application, extra durability and distinctive sales appeal. Use it for finishing refrigerators, ironers, stoves and countless other metal products.

DURANITES are plastic-base finishes made in various grades to meet special requirements—come in whites, clear, colors and any desired sheen. They may be applied by spray, dip or roller-coat and can be used with infra-red or convection heat. They cure in minutes!

ZAPON
REG. U. S. PAT. OFF.

ZAPON DIVISION
ATLAS POWDER COMPANY

Eastern Sales: Stamford, Conn. • Western Sales: No. Chicago, Ill.

SPECIALIZED PRODUCTION FINISHES... *Doing Tomorrow's Job Today!*

THOSE plating chemicals do look about the same, but Joe knows the resemblance stops there. The refinements in Harshaw Anodes and Chemicals have given Joe added improvements in his plating, which he fully recognizes.

He knows now that Harshaw guards the purity of their plating materials.

One control of purity, for example, is spectrographic analysis of raw materials, before they are used, then when they are in process, and finally to check the finished product. This investigation helps maintain and protect the purity of the plating chemicals Joe purchases from Harshaw.

Practical plating experience, combined with laboratory control and research, has enabled Harshaw to set the pace in new plating developments which in turn maintain top recognition for Harshaw in the plating industry.

Keep your production up and your scrap pile down . . . place your order with Harshaw for nickel, chromium, copper, cadmium, zinc, tin and lead plating materials. Buy *top performance*.

SEND FOR

- **Lead Plating Booklet of Practical Information**
- **32-page book listing Industrial Chemicals**
- **72-page price list of Laboratory Chemicals**

HARSHAW

THE HARSHAW CHEMICAL CO.
1945 East 97th Street, Cleveland 6, Ohio
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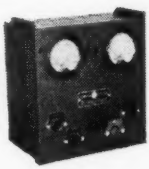
TO BEAT
POSTWAR
COMPETITION

Fully Automatic D-C POWER SUPPLY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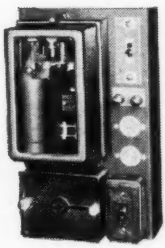
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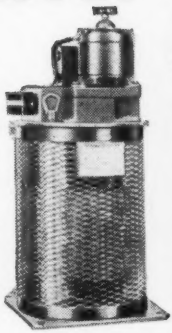
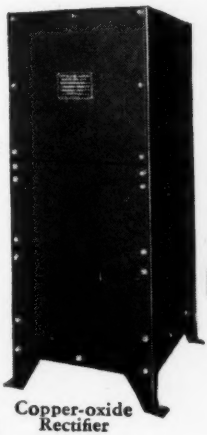

Automatic Control


Copper-oxide Rectifier

For Electroplating and Anodizing

Postwar, applying beauty and lasting protection to product finishes will be a highly competitive business. To meet this situation equip now with a G-E fully automatic d-c power supply.

For applications large or small there are many differently rated, low-cost G-E automatic combinations from which to choose. Each offers advantages for efficiency, reduced power bills and increased profits.

A G-E fully automatic power unit will eliminate the inherent dangers of the "human element." It will accurately maintain tank voltage from "No Load" to "Full Load" and provide smooth, "On Load" steady adjustment of power over the equipment's entire output voltage range.

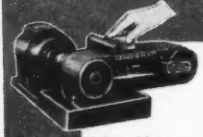
Operation is simple. Plating or anodizing is started by pressing a button on the operator's control box. Thereafter, everything is automatically controlled. When the tank load is ready for removal the system shuts off automatically and returns to a starting position for the next load.

For additional information write to Section A1051-106, Appliance and Merchandise Department, General Electric Company, Bridgeport, Connecticut.

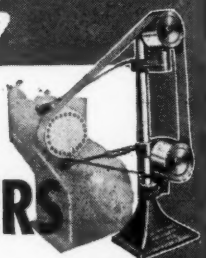
GENERAL ELECTRIC

Hammond

of KALAMAZOO



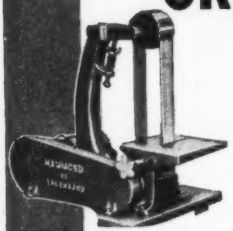
belt model —
e 400



BACKSTAND No.
see Model 3 le

Abrasive Belt
GRINDERS-POLISHERS

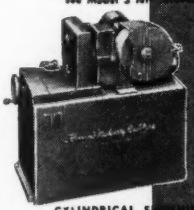
FOR FASTER, BETTER FINISHING



elt Unit, 2" Type F-2

FLEXIBLE BELT UNIT — Inexpensive bench or pedestal type for replacing the slow, more costly grinding and finishing methods now being employed throughout your plant.

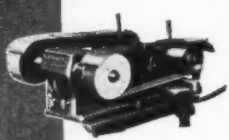
GRINDER - POLISHER COMBINATION — Uses belts or wheels or both on same machine, whichever set up is required to do the job. Available in bench and floor types.

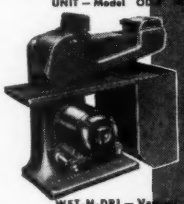


CYLINDRICAL F
UNIT — Model O

BACKSTAND-POLISHING LATHE UNITS — handles heavy duty finishing jobs faster . . . better.

BACKSTANDS — Either bench or floor types for converting your present polishing equipment into belt finishing units.



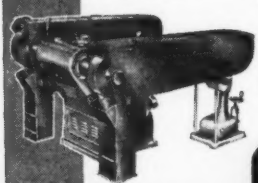


GRIND POLISHER COMBI-
NATIO — Use either belts
or wheels or both, 3" belts

WET-N-DRI — Ve
Horizontal 6"

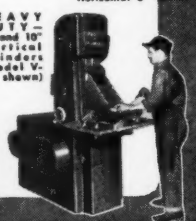
CYLINDRICAL FINISHING UNITS — for ¼" to 9" outside diameter tubes, rods, bars.

WET-N-DRI 4" and 6" Horizontal-Vertical GRINDERS, either bench or floor type units for high production, low-cost finishing.



BACKSTAND No. 3 and
Motorized Variable Speed
Polishing Lathe Unit

HEAVY DUTY — 8" and 10" Vertical floor type GRINDERS — Wet-N-Dri operating, handle wide range of small and large parts to be finished.



HEAVY DUTY — 8" and 10" Vertical Grinders (Model V-10 shown)

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CABINET, GENERAL PURPOSE & ABRASIVE BELT GRINDERS • AUTOMATIC & CYLINDRICAL FINISHERS • POLISHING LATHES

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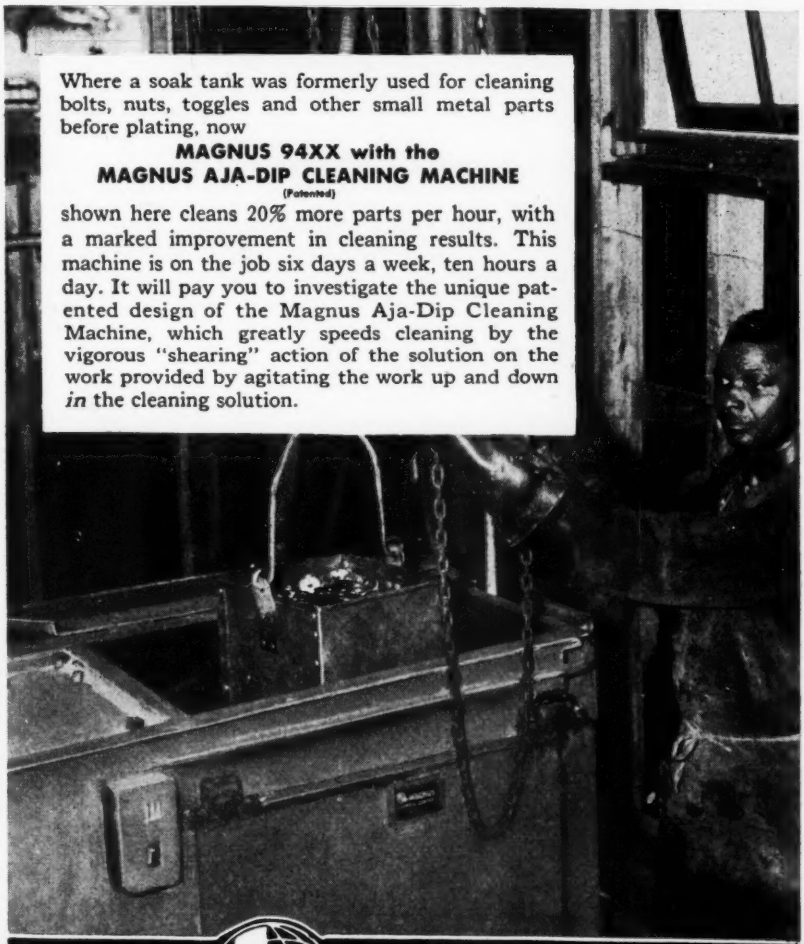
20% Production Boost...
Better Cleaned Parts before Plating



Where a soak tank was formerly used for cleaning bolts, nuts, toggles and other small metal parts before plating, now

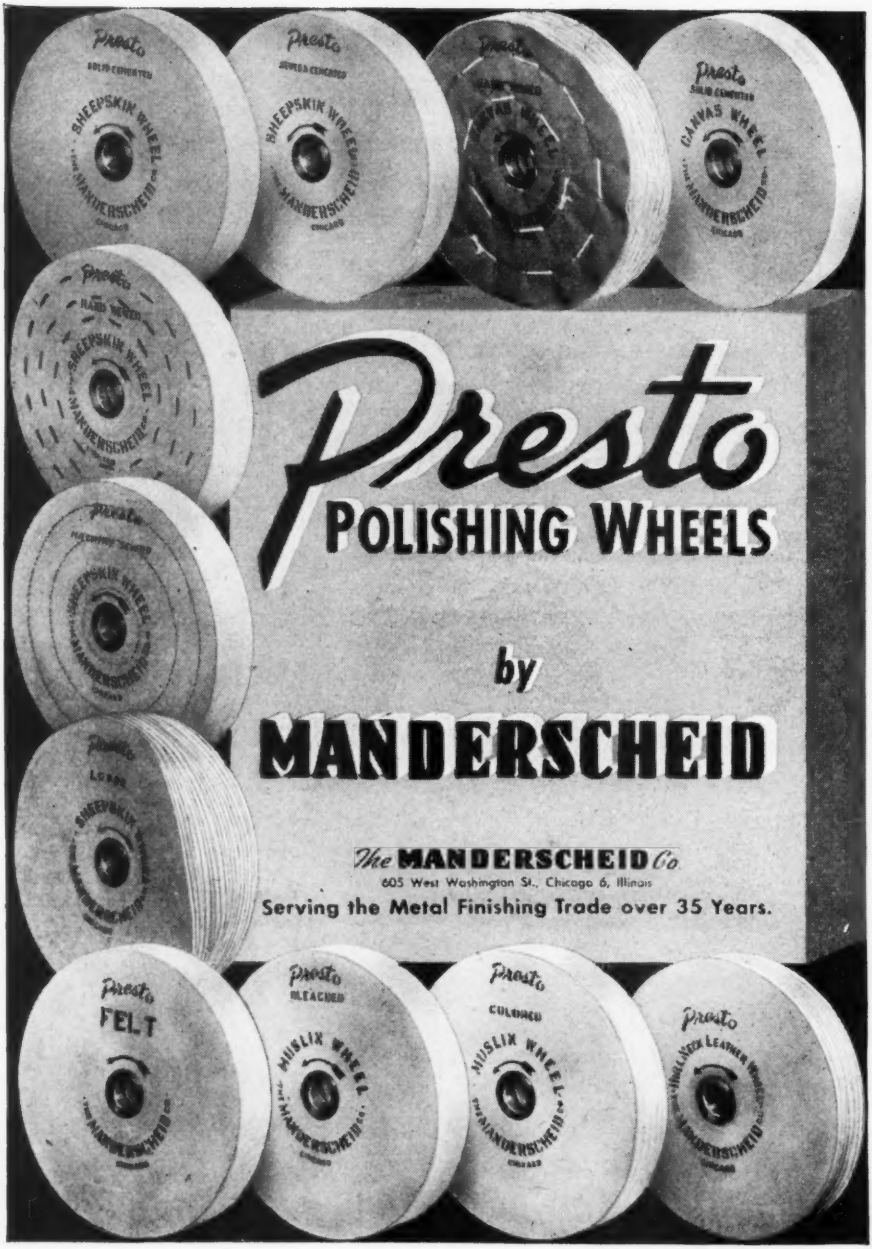
MAGNUS 94XX with the MAGNUS AJA-DIP CLEANING MACHINE
(Patented)

shown here cleans 20% more parts per hour, with a marked improvement in cleaning results. This machine is on the job six days a week, ten hours a day. It will pay you to investigate the unique patented design of the Magnus Aja-Dip Cleaning Machine, which greatly speeds cleaning by the vigorous "shearing" action of the solution on the work provided by agitating the work up and down *in* the cleaning solution.

MAGNUS

MAGNUS CHEMICAL COMPANY
41 SOUTH AVENUE, GARWOOD, N. J.

Cleaners • Machines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50 TO 10,000 G.P.H.

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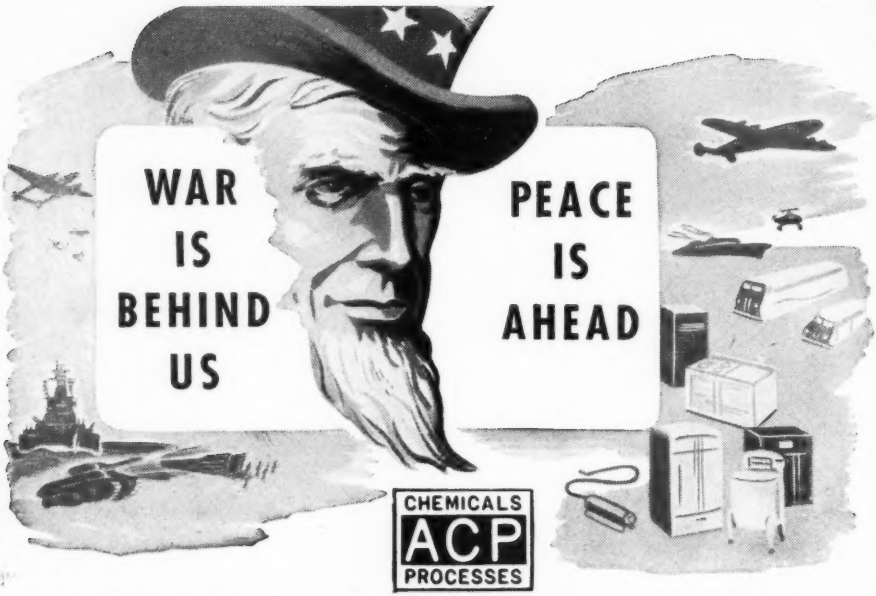

ACP Chemicals and Processes that helped win the War are now available to the metal-working industry to make more enduring the finishes on automobiles, farm machinery, refrigerators, washing machines and countless other necessities that will add comfort and pleasure to peacetime living.

210 A DEOXIDINE

Notable among these products is 210 A DEOXIDINE which has the distinct advantage of *cleaning* and *conditioning* at the same time; the combined operations are therefore carried thru in fewer stages — a saving in both time and equipment.

Power washers, heretofore used for alkali cleaning are satisfactory — also the large machines built especially for handling large production of large surfaces. Ordinary mild steel equipment is adequate — stainless steel is not required but may be used if already installed.

To Aid Rapid Reconversion

The simplicity of equipment and operation of 210 A Process will be a material aid to the metal working industry in reconversion to peacetime production. The low cost and excellent results obtained with DEOXIDINE for cleaning and conditioning were proved in wartime production. 210 A Deoxidine will be equally profitable to post-war producers.

ACP has served industry thru two World Wars and the intervening years of peace. This experience in the removal and prevention of rust, in inhibiting pickling baths and other applications of chemicals to the metal working industry is available to you to help speed your reconversion to normal production.

Our Technical Dept. will gladly assist you in the most effective application of our products to your manufacturing requirements. Write Dept. N-10.

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A. E. S. RESEARCH FUND

REPORT FROM FINANCE SUB-COMMITTEE

The Finance Sub-Committee is pleased to acknowledge the generous assistance given to the Research Fund by a large number of firms, individuals and Branch Societies. Their names are listed below together with the amount subscribed to September 15, 1945.

Those who have given $100.00 or more are listed separately as Sustaining Members of the Society. In a near future they will receive a letter confirming our understanding as to the amount which they wish to subscribe annually. This support from Sustaining Memberships will enable the Research Committee to devote its time to research problems rather than to the procurement of funds.

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The cost of DARCO is measured in pennies — a dime's worth keeps 100 gallons of solution clean for a week. Get some from your dealer or write us for a sample. If you have a special purification problem, we'll be glad to lend you assistance.

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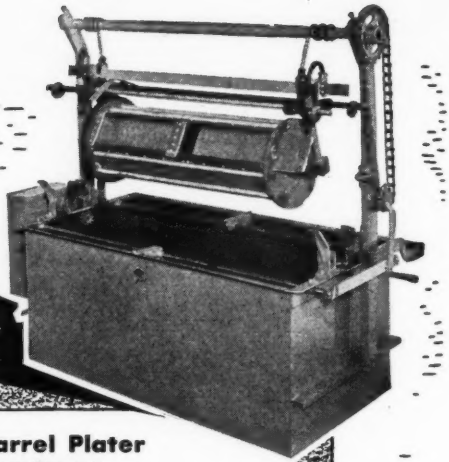

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MAURICE R. CALDWELL, *Chairman*

REFERENDUM VOTE SCHEDULED

Revised Newark Amendment on Sustaining Membership Ready for Vote

As requested at the 1945 Annual Business Meeting at Pittsburgh, the Newark Branch prepared an amendment to the amendment on Sustaining Members passed at the Annual Meeting and submitted it to be voted upon by referendum vote by the delegates to the 1945 meeting.

This amendment has been revised by the Law Committee under the chairmanship of Mr. George Wagner and approved by the Executive Board at its meeting in New York City on Friday, September 21, with the recommendation that it now be published in the REVIEW in accordance with the provisions of the Constitution and that a referendum vote by letter ballot upon this amendment be obtained.

The revised amendment is as follows:-

"Part I. The Supreme Society. Article II. Membership. Section 4. Sustaining Members:—Any firm or person directly interested in the electroplating industry or the aims and welfare of this Society may, upon the subscription of not less than $100.00 per year, become a Sustaining Member. The acceptance of such subscription by a majority vote of the *Executive Board* shall constitute the *granting of Sustaining Membership.* Sustaining Membership shall terminate when subscriptions have ceased for one fiscal year. All funds received from Sustaining Members shall only be used *for research on problems and processes directly related to the art and science of electroplating or any of its allied arts.* The names of Sustaining Members shall be published each year in the PRO-

(*Continued on page* 1052)

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PART XXI

THE NUCLEUS OF THE ATOM

Samuel Glasstone, D. Sc. Ph. D.

Positive Charges on the Nucleus

IT was seen in the preceding article that an atom of any element consists of a small positively charged nucleus, carrying most of the mass of the atom, surrounded by a number of negatively charged electrons. The next problem to consider is the number of positive charges carried by the nucleus of any particular atom. It will be recalled (Part V, *Monthly Review*, March 1944) that for each element the atom has a definite weight, the value of which relative to that of the hydrogen atom is called its "atomic weight." If the elements are arranged in order of increasing atomic weight, with certain minor exceptions which need not concern us here, it is possible to ascribe a number to each element, representing its ordinal number in the atomic weight series. This is called the "atomic number" of the element. For example, the first eight elements in order of increasing atomic weight are as follows: 1. hydrogen; 2. helium; 3. lithium; 4. beryllium; 5. boron; 6. carbon; 7. nitrogen; 8. fluorine. The name of each element is preceded by its atomic number.

In the course of a study of the deflection of alpha-particles (see Part XX) by the nuclei of certain atoms, Rutherford, and later others, found by calculation that the charge carried by these nuclei was in each case approximately equal to the atomic number of the element. From these and other observations, such as those connected with the properties of the characteristic X-rays produced by the various elements, the important conclusion was drawn that the number of positive charges carried by the nucleus of any element is equal to its atomic number, as defined above. Thus the nucleus of the hydrogen atom has one positive charge, that of the helium atom two, that of the lithium atom three, and so on. By means of this rule it is an easy matter to determine the magnitude of the positive charge carried by the nucleus of any atom. For example, when arranged in order of atomic weights, the element silver is found to be the forty-seventh. Consequently, silver has an atomic number of 47, and its nucleus carries 47 positive charges.

Increasing Complexity of Atomic Structure

Since an atom as a whole is electrically neutral, the number of electrons, i.e., unit charges, surrounding the nucleus must be exactly equal to the number of positive charges on the nucleus itself. That is to say, the number of electrons present in any atom is also equal to its atomic number. An atom of silver, for instance, would thus consist of a nucleus carrying 47 positive charges, surrounded at a distance which is relatively large in comparison with the size of the nucleus, by an arrangement of 47 electrons. The element of lowest atomic weight, namely hydrogen, has an atomic number of unity, and so it is made up of a nucleus with a single positive charge and a single electron. At the other extreme, there is the element of highest known atomic weight, uranium. This has an atomic number of 92, and so the atom consists of a nucleus carrying 92 positive charges sur-

rounded by 92 negatively charged electrons. In between there are the ninety other elements, with the number of positive charges and electrons determined by their respective atomic numbers. It is seen, therefore, that the structure of atoms increases steadily in complexity with increasing atomic weight of the element, from hydrogen to uranium.

Structure of the Nucleus

Since the number of electrons associated with any element does not exceed 92, and the mass of the electron is very small compared with that of even the lightest atom (see Part XX), it is evident that most of the mass of an atom must be concentrated upon the nucleus. A simple calculation shows that the mass of the nucleus constitutes at least 99.95 per cent of the total mass of an atom. This fact is highly significant, for it leads to the conclusion that the nuclei of most atoms must contain other entities, in addition to the positive charges considered so far. Consider, for example, the hydrogen atom: the nucleus carries a single positive charge, as seen above, and the mass of the hydrogen atom, and hence of its nucleus, is unity (or, more exactly, 1.008 on the modern atomic weight scale). A single positive charge may thus be considered to be associated with (approximately) unit mass on the atomic weight scale. This unit positive charge, with a mass of unity, which is believed to play a fundamental role in nuclear structure, is called a "proton," from the Greek word (*protos*) meaning "the first." It follows, that the nucleus of the hydrogen atom consists of a single proton. Suppose the nuclei of other atoms were made up of protons only; their masses would then be equal to the number of protons, and hence to the number of positive charges, or to the atomic number. For example, helium, whose nucleus carries two charges, would have a mass of two, lithium would have a mass of three, and so on. Silver, with its 47 positive charges, would have an atomic weight of about 47, and uranium, with a positive charge of 92 units on its nucleus, would have a mass of 92 on the atomic weight scale. The actual atomic weights are, however, larger than these numbers; thus, helium has an atomic weight of 4, lithium 7, beryllium 9, etc., while silver is about 108 and uranium approximately 238. It is thus obvious that the atomic nuclei of all atoms, with the exception of hydrogen, must contain relatively heavy particles, in addition to protons.

The Neutron in Nuclear Structure

Various ideas were proposed from time to time concerning the particles present in the atomic nucleus, but it was not until 1932 that a satisfactory theory was put forward. In that year there was discovered a new elementary particle whose probable existence had been forecast some years previously; this particle is known as the "neutron." The neutron, as its name implies, is electrically neutral; that is to say, it carries no electrical charge, neither positive nor negative. However, it has a mass of approximately unity on the atomic weight scale, almost identical with that of the proton, and so its presence would contribute mass to the nucleus, without affecting its charge. It was suggested that all atomic nuclei, with the exception of hydrogen, consist of protons and neutrons; the number of protons is equal to the atomic number, as stated earlier, while the total number of protons and neutrons together is equivalent to the atomic weight of the element. This theory accounts for all the known facts. Consider, for example, silver: its atomic number is 47 and its atomic weight is about 108. Hence the nucleus of the silver atom consists of 47 protons and 61 neutrons. Since the neutrons are electrically uncharged but have a mass of unity, the total charge on the nucleus is still 47, but the atomic weight is $47 + 61 = 108$. The constitution of the nucleus of the atom of any element, in terms of protons and neutrons, can be readily derived in an analogous manner.

Isotopes

If the foregoing arguments are correct, and the mass of an atom is due to a definite whole number of protons and neutrons, each of which has a mass of unity, the atomic weights of elements should themselves be exactly, or close to, whole numbers. An examination of a table of accurate atomic weights shows that this is the case in some instances, but there are certain very marked exceptions. A particular example is provided by the element chlorine, which has an atomic weight of nearly

(*Continued on page* 1050)

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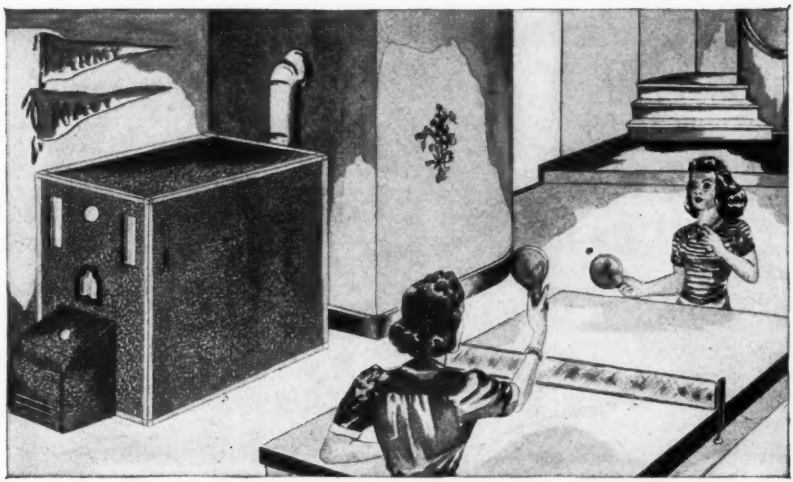

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1946 Convention in Pittsburgh

As a result of the termination of the war, it is expected that the Office of Defense Transportation will soon lift restrictions on convention travel. It is virtually certain that the 1946 Convention will be held in Pittsburgh as scheduled.

In view of these developments, Convention Chairman S. S. Johnston called a meeting of the Convention Committee, Saturday, September 8th, at the William Penn Hotel. At the meeting, Mr. Johnston reappointed all the members of the 1945 Committee to their respective portfolios for the 1946 Convention. In addition, F. R. Keller was appointed General Vice-Chairman. Assuming O.D.T. approval, the Convention will be held at the William Penn Hotel, June 17th to 20th inclusive.

Members of the Committee are as follows:

General Chairman — S. S. Johnston, Weirton Steel Co., Weirton, W. Va.

Vice-Chairman, Secretary and Treasurer — F. R. Keller, 1102 Hiland Ave., Coraopolis, Pa.

Educational — R. A. Dimon, 210 Semple St., Pittsburgh, Pa.

Hotel Reservations — J. L. Wray, 230 Beverly Rd., Pittsburgh 16, Pa.

Registration — Leo J. Schmitt, 116 Mendota St., Pittsburgh 12, Pa.

Publicity — W. J. Hennessy, Pennsylvania Salt Mfg. Co., 541 Union Trust Bldg., Pittsburgh 19, Pa.

Entertainment and Banquet — H. F. Saylor, 247 S. St. Clair St., Pittsburgh 6, Pa.

Transportation — R. O. Hummel, Harshaw Chemical Co., Carson and 7th St., Pittsburgh 3, Pa.

Ladies' Committee — Mrs. R. A. Dimon, 515 Hastings Ave., Pittsburgh 6, Pa.

Exhibits — Wilfred S. McKeon, Sulphur Products Co., Greensburg, Pa.

W. J. Hennessy

Papers for the 1946 Convention

Our victories over Germany and Japan have assured that the 1946 Convention will be held in Pittsburgh this coming June. It is none too early for prospective authors to begin thinking about papers which could be submitted for presentation and discussion. We hope to carry out the same plan that was contemplated for the cancelled 1945 meeting, namely to group papers relating to the same general subject at the same session of the Convention and to have each such session presided over by a recognized authority on subject in question.

Some of the subjects that are given consideration are:

Theoretical Papers
Electrolytic Coating of Strip
Problems in Reconversion
Organic Coatings
Research Committee Work

Papers should be submitted in triplicate to the undersigned not later than April 1st, and abstracts, for inclusion in the Convention Program, not later than March 1st.

Several factors, such as the central location of Pittsburgh, and the two years that will have elapsed since the last meeting, should make this an outstanding meeting. Prospective authors are urged to take the opportunity which will be provided here for presenting and discussing their work before this Society.

Richard A. Dimon

32nd PROCEEDINGS

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THE AMERICAN ELECTROPLATERS' SOCIETY

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RESEARCH COMMITTEE MEETING

By A. KENNETH GRAHAM
Executive Secretary

The Research Committee of the American Electroplaters' Society met at 9:30 A.M., Saturday, September 22, 1945 at the Chemists' Club in New York City.

In addition to the committee ("The Nine Old Men") the following officers and guests were present:

Mr. W. L. Pinner, President, Mr. Sam Johnston, President of the Pittsburgh Branch, Dr. R. J. McKay, International Nickel Company, representing the A.S.T.M. B-8 Committee, Dr. Louis Weisberg, Vice-Chairman of the Research Directing Sub-Committee.

After the minutes of the previous meeting were read and approved, the importance of publicizing the research results in both the MONTHLY REVIEW and the Annual PROCEEDINGS was discussed. A resolution of the Executive Board with reference to the publication of research papers was read in which the Board strongly advised that the papers should be published in the MONTHLY REVIEW as they become available, that reprints be prepared for sale and that provisions be made at an Educational Session of the Annual Convention for presentation of a summary of all projects. The reasons influencing these recommendations were the needs:-

1. To improve the scientific status of the Society through its most widely read and most frequently appearing publication.

2. To improve the quality of the REVIEW.

3. To increase the demand for the publication and its distribution to public libraries and institutions.

Accordingly, the Research Committee agreed to follow the above recommendation and furthermore, passed the motion that at least one full Educational Session at the 1946 Convention be devoted to summary reports on the various research projects.

The resolution introduced by the Philadelphia Branch and submitted to the Annual Meeting in June had been referred to the Research Committee. Dr. Blum submitted the following report on this resolution which was referred back to the Executive Board for further action.

"TEACHING OF ELECTROPLATING IN PUBLIC SCHOOLS

"At the meeting of the A.E.S. Research Committee on July 14, a resolution of the Philadelphia Branch regarding classes in electroplating in public schools was referred to the undersigned to prepare and report recommendations to the Research Committee. The following possibilities are suggested for your consideration.

1. "In view of the highly specialized activities and the relatively small number of persons directly engaged in electroplating, the inclusion of a definite course in electroplating in the regular curriculum of most public schools does not appear to be warranted. Such references as are commonly made to electroplating in the present high school courses in physics and chemistry will serve to acquaint students with the principles involved in plating.

"It is possible, however, that in a few large plating centers a vocational high school could well include a course on plating for one semester, preferably near the end of the high school course, in order to teach those who might decide to go into the plating industry.

2. "It is possible and desirable to stimulate interest of high school students in electroplating by means of one or two lectures each year on the methods and applications of plating. Because few high school sceince teachers are acquainted with details of plating, such lectures can best be given by some plater or chemist who is directly associated with the industry. Each local Branch of the A.E.S. might well arrange with the local high schools to supply speakers qualified to give such lectures, either to the chemistry or physics classes, or to a 'science club' that meets

after school hours. Such lectures might include slides showing typical plating plants, simple experiments to illustrate the principles, and specimens of plated products, especially those from local industries.

"If there is sufficient interest in such a plan, the A.E.S. could appoint a sub-committee to draw up an outline of such lectures as a guide to local speakers.

3. "The public schools may also cooperate with the plating industry by furnishing space and facilities for evening classes for platers, to be organized under the auspices of the local A.E.S. Branch. If the school supplies a science teacher the Branch should cooperate with him in preparing outlines for the courses; which, in successive years might include (a) principles of chemistry, (b) analysis of plating solutions, and (c) more advanced studies in electrodeposition. Here again, the A.E.S. might cooperate by preparing outlines for such courses.

"The principal advantages to the electroplating industry from such educational activities are (1) the attraction to this industry of more young, ambitious persons, and (2) the advancement of persons engaged in the industry so that they can more readily and more intelligently apply the results of research and development in this field. Both of these aims are eminently proper for the A.E.S."

Mr. M. R. Caldwell, Chairman of the Fiance Sub-Committee, reported that the committee had set a goal of 400 Sustaining Members for the year 1945-46. It is planned to establish quotas for the Branch Societies based on one sustaining member for every ten branch members and to follow up the program through the Branches through his Committee members. The campaign will start immediately and a report is expected in January.

The Secretary reported a total subscription to the A.E.S. Research Fund to August 31, 1945 amounting to $51,454.17.

Dr. R. M. Wick, Chairman of the Research Directing Sub-Committee, reported in detail on his negotiations with the legal counsel for the Society relative to:

1. Agreements with universities and project directors for the execution of research projects.
2. Development of research policy for the A.E.S. with respect to the Research Committee.
3. Tax matters.
4. Patent matters.

It is hoped to establish the projects at the various educational institutions on a fellowship basis and by so doing to further advertise the A.E.S. and its research activities.

The Committee is actively planning for seven projects during the coming year. This includes further work on:

Project #1, Stripping of Copper.

Project #2, Analysis of Impurities in Plating Baths.

Project #3, Adhesion of Electrodeposits.

The new projects include:

Project #4, A Study of the Effect of Polishing on Non-ferrous Metals and on the Quality of Plated Coatings.

Project #5, The Effect of Impurities and Methods of Purification of Plating Baths.

Project #6, A Study of Porosity of Plated Coatings.

Project #7, A Study of Methods of Measuring Thickness.

A complete report on these matters will appear in a future issue of the MONTHLY REVIEW but it should be mentioned that an effort is being made to find project directors who are especially qualified for the subjects under investigation and at the same time to locate the projects at institutions which not only have the necessary facilities but which, as far as possible, are geographically distributed throughout the country with respect to the location of our various branches.

The importance of planning for suitable topics for future investigation was emphasized and it was agreed that at least one-quarter of the projects should deal with fundamental matters on which more adequate information is needed. It is also the desire of the Committee to continue to obtain suggestions for projects from the branches and members of the Society.

There will be quarterly progress reports summarizing the activities of the various projects which will be published in the REVIEW.

The Committee elected E. T. Candee the Vice-Chairman of the A.E.S. Research Committee to assist C. E. Heussner.

It is planned to hold the next meeting of the Research Committee at the Palmer House in Chicago at 10:00 A.M., Friday, January 18, 1946.

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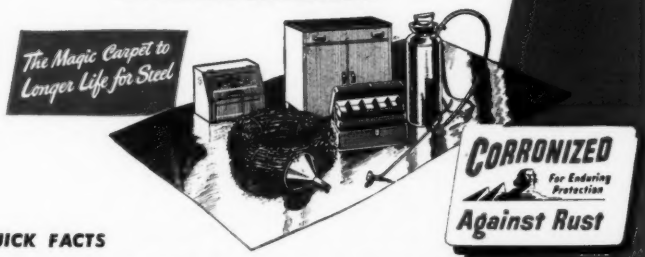

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THE ADHESION OF ELECTRODEPOSITS
II. GENERAL CONSIDERATIONS
A.E.S. Research Project No. 3

Project Director: A. L. Ferguson

Associate: Elmer F. Stephan

Chemistry Department, University of Michigan, Ann Arbor, Michigan

Outline of Paper

Introduction 1006

Adhesion is of primary concern in electrodeposition

The two major factors are methods of securing and methods of measuring adhesion

Adhesion is complicated by factors of uncertainty 1007

General plan adopted by the author in presenting the material of this paper (Footnote.)

The forces involved in adhesion 1007

All forces involved are electrical or magnetic

Supporting evidence by Langmuir

Supporting evidence by Glasstone 1008

Adhesive force may exceed cohesive

Strength of force increases at a greatly increasing rate with decreasing distance

Adhesion depends upon closeness of contact

Adhesion may be greater than tensile strength

Diagramatic illustration 1009

A surface impurity may not prevent a perfect bond

Perfect adhesion is not an absolute quantity 1009

Every bond has its own individuality

Demonstrations of bond strength greater than *apparent* tensile strength of either metal

Work of Hothersall 1010

Apparent tensile strength may not be real tensile strength

Evidence of Hothersall

Meaning of degree of adhesion and perfect adhesion 1011

Confusion in concepts

Illustration by Hothersall

Interpretation by Blum 1012

The highest type of bond between deposit and base metal 1012

Atomic bonding is the highest order

Controversy concerning continuation of crystals of base metal

Evidence by Piersol

Evidence by Blum and Rawdon

Evidence by Graham

Evidence by Hothersall 1015

Evidence by Faust 1019

Polished versus etched surfaces for better bonding 1019

Evidence by Piersol

Evidence by Crosby and Gilbertson 1020

Evidence by Hothersall

Evidence by Blum

Evidence by Faust

Evidence by Mesle 1021

Evidence by Ollard

Evidence by Yates

Introduction

ADHESION of electrodeposited metals to the base metal has always been of major concern to the electroplating profession. Its importance has increased rather than decreased with time and even more so during recent years since thick electrodeposits have come into increasing general use through such processes as building up of worn parts by iron, chromium and nickel and through the development of electrodeposited metals for bearings.

There are two major factors involved in adhesion; one is concerned with methods for securing adhesion and the other with methods for measurement. These are so intimately related that it is difficult to consider them separately, however, the present paper will be confined as closely as possible

to the question of methods of measurement.

The whole matter of adhesion is further complicated by some factors of uncertainty that should receive consideration before entering upon the main topic of the paper. In the first place, one might ask what is adhesion? What is adhesion due to? What causes it? What forces are involved? In the second place, one might ask whether the conclusions arrived at concerning the methods for securing and for measuring adhesion of one electroplated metal to one base metal may be applied to other electroplated metals to that same base metal, or of electrodeposited metals to different base metals. In other words, do different electrodeposited metals and different base metals possess personalities of their own and require individual attention. In the third place, one might ask whether the definition of adhesion should have universal application. In other words, may a deposit be said to be adherent for some purposes and not for others? Can one set of standards or specifications for relative degrees of satisfaction in adhesion be set up to apply to all cases, or should several sets be used each for a given purpose? And in the fourth place, one might even ask the question what is to be considered perfect adhesion. Strangely enough there is a distinct lack of agreement on the answer to this last most basic question. Each one of these factors will be briefly considered.*

The Forces Involved in Adhesion

As pointed out above, one question which should be considered in any problem related to adhesion is, to what is adhesion due, or what are the forces involved in adhesion? From reading text books and published literature one would get the impression that there are many different kinds of forces producing adhesion. Some of the more commonly named forces are: gravitational, magnetic, electrical, adhesive, cohesive, van der Waals'; chemical, valence, covalence, atomic, etc. It is a very serious question as to whether these different names mean that there are many distinct kinds of forces or whether many of the different names are used simply for convenience or due to historical development, but actually refer only to different manifestations of the same force or different degrees of the same force. A whole book might be written on this subject, but attention will be drawn here to only a few points. It is just about universally accepted now that all matter is made up of molecules. Molecules of different kinds of matter are held together by so-called adhesive forces, those of the same kind by cohesive forces. Molecules are composed of atoms held together by so-called chemical, van der Waals', electrovalent, or/and covalent forces. Atoms in turn are made up of a central part which carries the mass of the atom and is positively charged, and an outer part made up of enough electrons or negative charges to neutralize the positive charge on the inner part. Since all matter is made up of a combination of atoms into molecules and, since *pure* material is made only of the same kind of molecules, and since all *other* material is made only of different kinds of molecules, it is difficult to account for the existence of any basically different types of forces other than those found in the ultimate building blocks of all molecules, namely, the electrical and magnetic forces in the atom. If this point of view is accepted, then the different names for forces involved refer to different manifestations or degrees of intensity of the same basic forces within the atoms themselves.

The point of view expressed above that the forces involved in adhesion are identical with those involved in cohesion, adsorption, chemical reactions and in the formation of crystals, in other words, that they are all atomic in nature is supported by much experimental evidence and many outstanding authorities in chemistry. One of the best known among these is Irving Langmuir, of the General Electric Company, Schenectady, N. Y. In one of his articles[2**] he makes the following remarks:

"In the past it has been customary to consider that solids and liquids are held together by the "forces of cohesion" and are called "physical forces" as distinguished from chemical forces. In the following pages the writer hopes to show that there is

*In the discussion of these factors and in fact throughout the whole paper, extensive use will be made of the direct words of individuals as recorded in the literature. The objective is to make the literature search so exhaustive that any individual interested in the subject in the future might feel it is not necessary for him to make a similar survey. It is recognized that this objective is not attained 100 per cent, and any additions to the bibliography will be much appreciated.

**Reference numbers refer to "BIBLIOGRAPHY" published in September issue.

no present justification for this distinction between chemical and physical forces. Cohesion, adsorption and surface tension are all manifestations of forces similar in their nature to those acting between the atoms of solid bodies. It is therefore advantageous to look upon these forces as direct results of chemical affinity. The surface of a crystal or solid must be looked upon as a sort of checker-board containing a definite number of atoms of definite kinds, arranged in a plane lattice formation. The space between and immediately above these atoms is surrounded by a field of electromagnetic forces more intense than that between the atoms inside the crystal."

The following is one of the conclusions stated in this article by Langmuir:

"There is no present justification for dividing interatomic or intermolecular forces into *physical* and *chemical* forces. It is much more profitable to consider all such forces as strictly chemical in nature. Evaporation, condensation, solution, crystallization, adsorption, surface tension, etc. should all be regarded as typical chemical phenomena."

As part of another conclusion he states:

"A large number of experimental results are given which prove conclusively that adsorption is very frequently the result of the strongest kind of chemical union (primary valences) between the atoms of the adsorbed substance and the atoms of the solid."

Another independent type of evidence which also demonstrates that the forces of adsorption are chemical in nature is that gained from heats of adsorption. This evidence is summarized in a statement by S. Glasstone:[100]

"The chemical nature of the forces involved (in adsorption) is indicated by the heats of adsorption which are of the order of 20 to 100 kg.-cal. per mol., so that the bonds formed between the metal and the adsorbed gas are almost as strong as those existing in stable stoichiometric compounds."

It is a question why Glasstone uses the qualifying word "almost" since these heats of adsorption are within the range of heats of chemical reactions.

There are several instances known in which the strength of the force between the adsorbed material and the metal is greater than the cohesive force or tensile strength of the metal itself. A commonly presented illustration is the case of oxygen adsorbed on tungsten. In the course of time the normal oxide of tungsten WO_3 distills from the tungsten surface and is deposited on the walls of the vessel. This proves that the so-called adsorptive force between the oxygen and the surface atoms of the tungsten wire is even greater than the so-called chemical force between these surface atoms of tungsten and the other tungsten atoms surrounding them.

It is universally accepted that the strength of a force increases with decrease in the distance over which it operates, the rate at which the strength increases with decrease in distance becomes much greater the shorter the distance, ultimately reaching a value of a high order of magnitude at interatomic distances. This means that the greatest manifestation of force strength is within the atom; the next in magnitude would be between the atoms within molecules, commonly called atomic or valence or chemical forces; the next would be between molecules or atoms of the same composition commonly called molecular or cohesive forces; and next those between molecules of different kinds, and commonly known as adhesive.

According to the modern concept of the structure of metals, only atoms are present. This means that all the forces, including those at the surface which result in adhesion are atomic or chemical in nature.

If the above analysis is correct, then the degree of adhesion for a given deposit and base metal becomes largely a matter of how intimate a contact can be made between atoms of deposited metal and the atoms of the base metal. It should be possible, theoretically, to make this contact so intimate that the force or bond between the deposited and base metals might be even greater than the forces between the atoms of deposited metal or atoms of base metal themselves, which are commonly called cohesive forces. Or, to put it differently, the tensile strength of the bond might be greater than the tensile strength of either the deposited or base metal. This means that the greatest secret to perfect bonding (the expression perfect adhesion is purposely avoided) is an absolutely clean base metal surface.

One might illustrate the points involved in the above discussion by reference to the diagram in Fig. 1. The dotted line AA represents the surface of an absolutely clean base metal surface, M represents atoms of the base metal, the lines connecting the M's represent the forces between the atoms; M′ represents atoms of electrodeposited metal or some other, so called, adsorbed material which was adsorbed between the time of cleaning and the starting of electrodeposition, or some material that was not removed by the cleaning process. Within the body of the metal the atoms have all their forces satisfied, but on the surface there must be forces which are not satisfied yet are of the same nature. These are represented by the vertical lines in Fig. 1 connecting the M and M′ atoms, These unsatisfied forces are extremely active and will tend to grab onto whatever comes along that will satisfy them. The author has frequently observed a freshly chemically cleaned surface acquire a visible tarnish within a few seconds. The presence, however, of a foreign material upon the surface of a base metal does not mean necessarily that a perfect bond is impossible with an electrodeposited metal. The surface forces of the base metal are fairly highly selective and even though they may be apparently satisfied by some impurity it is entirely possible that the atoms of an electrodeposited metal might more effectively satisfy them, in which case the previously bonded material would be displaced. This is a fact demonstrated by many experiments and extensively applied in some commercial processes including electroplating. It is probably a part of the explanation for the procedure of some times placing on the base metal a coating which preserves these forces until the plating process starts after which the coating is replaced by the electrodeposited coating and results in a perfect bond. An illustration of this is the anodic treatment of aluminum before the electrodeposition of another metal.

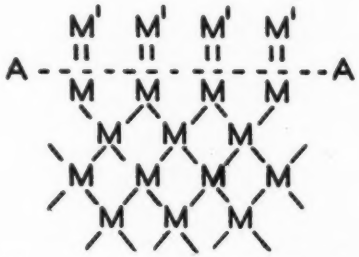

Fig. 1. Forces involved in adhesion.

Perfect Adhesion is Not an Absolute Quantity Expressible in Pounds per Square Inch

A second disturbing factor mentioned near the beginning of this paper has to do with the question as to whether conclusions arrived at concerning perfect adhesion, resulting from a study of one electrodeposit upon one base metal may be generalized to apply to any deposit upon any base metal. If the ideas presented above concerning the forces involved are accepted then some generalizations may be permitted, but for many of the details each case of electrodeposition must be considered by itself, both from the point of view of nature of deposited metal and of the base metal. It may be stated, for instance, that a perfect bond may be obtained when the base metal is *absolutely* free from foreign material or when such foreign material may be replaced by the electrodeposited metal during the process of electrodeposition. However, the strength of this bond expressed in pounds per square inch can not be taken as a standard for all perfect bonds. Every pair of metals would probably have a different numerical value, expressed in pounds per square inch, for perfect adhesion. Neither can it be said that a method of producing a chemically clean surface on one metal will do so on another. How one base metal is handled between the cleaning tank and the plating tank may not apply for another. Composition of bath, temperature, agitation, concentration, current density, etc. are all factors which must be studied for each individual metal so far as adhesion as well as other properties of the deposit are concerned.

If the concept presented here concerning the forces involved in adhesion is true then it certainly is not possible to set up any absolute scale of perfect adhesion in pounds per square inch. The maximum forces of attraction are distinctly specific for each pair of base and deposited metal. It might be possible to set up a standard in abso-

lute units for each pair of metals provided a device were available by means of which the bond strength could be measured accurately. No such device has been perfected. As pointed out above and demonstrated in practice, the strength of a bond between the deposited and base metals may be greater than the strength between the atoms of the respective metals or the so-called tensile strength of the metals. In such a case it would not be possible to measure the true bond strength. There are differences in opinions among authorities as to how to designate the adhesion when this is the situation.

Some experimental demonstrations of the existence of a bond strength that is greater than the tensile strength of one of the metals are contained in the article by Hothersall.[94] Some extracts from this article follow:

"In previous work (A. W. Hothersall, Trans. Electrochem. Soc., 1933, 64, 83) the author has shown that, when suitable cleaning treatments are used, a high tensile stress, acting at right angles to the general plane of the junction of deposit and base, is required to detach nickel deposits from a variety of basis metals. When fairly pure metals are used as a base, the stress required frequently approximate a tensile strength of the base, which is often less than that of the nickel deposit. Exceptions do occur and some of the causes for the basis metal, steel, will be discussed in a later part of this paper. Typical adhesion values using the Ollard method of test are given in Table I."

"Results of this high order, coupled with the fact that the fractures occurred not at the interface but entirely in the body of the underlying metal, prove that a strong bond existed between the two metals."

It will be noted that the fracture occurred in the base metal and not at the bond between plate and base metal. It should be pointed out, however, that this does not mean necessarily that the bond strength is greater than the normal tensile strength of the base metal. The surface layer of base metal may be weakened by various machining, rolling, polishing, etc. operations; or by pickling or other cleaning operations during which gases are liberated at or within the metal surface. The importance of these factors is well expressed in another paragraph from the same article by Hothersall.

"It must be remembered that adhesion tests of the type used in this work impose severe stresses upon the surface layer of the steel. Any weakness, even if only present to a depth of a few Angstrom units is as harmful as if the entire metal was weak. Machining or abrasion with sharp particles (emery) for example, probably leave the surface with minute tears and

TABLE I

TYPICAL ADHESION VALUES FOR ELECTRODEPOSITED NICKEL ON VARIOUS METALS*

Metal	*Condition*	*Typical Adhesion values lb./sq. in.*	*Location of Fracture*
Mild Steel	Rolled Bar	63,000	In steel
Nickel Steel	Forged	72,000	In steel
Copper	Extruded Rod	41,500	In copper
Brass 70:30	" "	53,000	In brass
60:40	" "	43,000	In brass
Aluminum	" "	8,000	In aluminum
Tin	Melted Film	3,960	In tin
Lead	Electrodeposited film on steel	2,470	In lead

*All specimens tested as deposited without subsequent low temperature treatment.

cracks and in a work-hardened and stressed condition. Polishing removes the torn surface but leaves a distorted layer below with a thin flowed film of amorphous structure at the surface, probably contaminated with polishing composition and oxide. Nickel deposits formed upon steel after such treatments are liable to be poorly adherent for two reasons (1) the intrinsic weakness of the surface (2) the additional weakness due to the embrittling effect of hydrogen discharged during cleaning and plating processes. As is well known from numerous researches on the effect of pickling and plating on the embrittlement of steel, this metal is especially susceptible to embrittlement when stressed. It is to be expected, therefore, that if the nickel is deposited upon a stressed surface, the surface will become seriously weakened either by being embrittled or by the production of actual cracks; the effect of the stress in the nickel deposit itself may aggravate the tendency of the embrittled surface to crack."

The Meaning of Degrees of Adhesion and Perfect Adhesion

The values in the above table and the accompanying remarks bring to attention the third basic disturbing factor involved in any discussion on adhesion mentioned at the beginning of this paper. It has to do with the very definitions themselves of such expressions as degree of adhesion and perfect adhesion. In discussions involving such expressions, some authors state definitely the meanings to be attached to them while others do not. This has lead to much confusion. As an illustration, the following statements are quoted from a paper by Hothersall.[94]

"The term adhesion is used in this paper to indicate the force which must be applied to separate a deposit from the base on which it has been formed, irrespective of whether fracture occurs at the junction or elsewhere.

"The importance which is commonly attached to the degree of adhesion of an electrodeposited coating varies with the conditions under which the article is plated and subsequently used. In certain special applications of electrodeposition such as the building up of worn or under-sized parts, which has been successfully practiced in England for over twenty years, success depends largely upon the ability to produce, consistently, strongly adherent coatings which will withstand the severe stresses often applied in machining and in use. With decorative or protective coatings, which rarely exceed .002 inch in thickness, the plater is apt to consider the adhesion of his coating to be satisfactory if the normal percentage of rejects in the plating shop is kept down to reasonably small numbers. Apart, however, from the obvious advantages of working with an adequate margin of safety, it is important to consider the possible effects of poor adhesion on the serviceability of the article. To enable such effects of poor adhesion to be properly assessed, it is necessary to know something about the degree of adhesion which can be obtained and why practice sometimes falls short of this ideal. This knowledge may also be important in enabling failures to be remedied or avoided and in assisting the development of improved methods to meet more stringent conditions of service.

"It is useful to remember, when attempting to correlate the results of adhesion tests such as are given in this paper with the behaviour of coatings in practice, that the term 'adherent deposit' has no meaning other than that the deposit did not show any sign of separation under the conditions to which it was exposed. It is possible for thin, poorly adherent coatings to undergo what may appear to be a drastic test without signs of separation, the behaviour in a given test often depending on a complex series of variables which include the thickness and mechanical properties of the deposit, the mechanical properties and surface roughness of the base. The tests used in this work were selected with the object of obtaining positive results as free as possible from such variables."

Attention should be drawn especially to Hothersall's interpretation of adhesion, that it is "the force which must be applied to separate a deposit from the base on which it has been formed, *irrespective of whether fracture occurs at the junction or elsewhere.*" Also the inference is clear that the expression "adherent deposit" might be applied to a given case when tested, by one method, or when a given use is in mind, while it might not be applicable if other

tests were used or other applications anticipated.

In a communicated discussion of the paper by Hothersall from which the above quotations were taken, W. Blum makes the following comments on the interpretation to be placed upon "adhesion" or perfect adhesion.

"Tests involving deformation of the base metal may be influenced by the properties of the latter. However, to the extent that detachment of a coating may be expected to result from deformation in service, ability to withstand in a test the maximum possible deformation may be considered as evidence of satisfactory if not perfect adherence."

This statement indicates that Blum would qualify "perfect adherence" according to the particular use to which the deposit will be subjected in actual practice.

Later in his discussion Blum makes another highly significant statement concerning his interpretation of the expression "perfect adhesion."

"On page 11, reference is made to the effect of an intermediate film of a weak metal. A striking example was found in plating nickel over a thin layer of zinc or cadmium on steel. The nickel coating could be easily pulled, leaving a film of zinc or cadmium on *both* the steel and the nickel. *In such a case, there is perfect adhesion,* though the *apparent adhesion is poor.* In fact, it might be considered that, whenever fracture occurs in a base metal or undercoat, the adhesion of the outer coating is *perfect by definition.*"

The Highest Type of Bond Between Deposited and Base Metals

There is one more point of a general nature involved in any discussion of adhesion of electrodeposits to base metal. It was pointed out early in the paper that the forces involved are really chemical or possibly even better called atomic. It was also pointed out that the strength manifested in any given case depends upon how close the atoms come to each other and that the strength decreases at an increasingly higher rate with increase in distance apart becoming practically zero when the distance is equal to a few molecular diameters. Probably the most familiar name given to the force involved in bringing about the bond between deposited and base metals is crystallizing force. The strongest possible bond should be, therefore, one in which the atoms of electrodeposited metal continue the same crystals as present in the surface of the base metal. Whether the continuation of such crystal growth ever takes place has been and still is a controversial subject. Another type of bond which should be of the atomic nature is the formation of a metallic compound or alloy between the deposited and base metals.

R. J. Piersol makes this statement:[47]

"In 1924, in an attempt to plate lustrous chromium directly on the polished surface of a spun flood-light reflector made from cold rolled copper, visual inspection showed that the grain structure of the copper was faithfully reproduced by the chromium and microscopic examination indicated that the crystal structure was carried through from copper to chromium."

The first study recorded in the literature of an attempt to demonstrate the influence of the structure of the base metal on the structure of the deposit is presented by W. Blum and H. S. Rawdon.[10] They state that:

"It is shown that if copper is deposited electrolytically upon cast or rolled copper which has been cleaned in alkali, the structure of the base metal does not apparently affect that of the electrodeposit. If, however, the surface of the base metal has also been treated with nitric acid, the electrodeposited copper possesses both the crystal form and orientation of the base metal."

Fig. 2 contains photographs used to prove this statement.

In an article[11] by A. K. Graham, more evidence of the continuation of the crystal structure of the base metal in the electrodeposit is presented. Graham takes exception to the conclusion of Blum that the continuation of crystal structure depended upon a dip into a nitric acid bath. Graham concludes that:

"Reproduction, therefore, does not depend so much on the preliminary chemical treatment as on the state of the metallic surface."

Several microphotographs are presented which illustrate continued growth of the

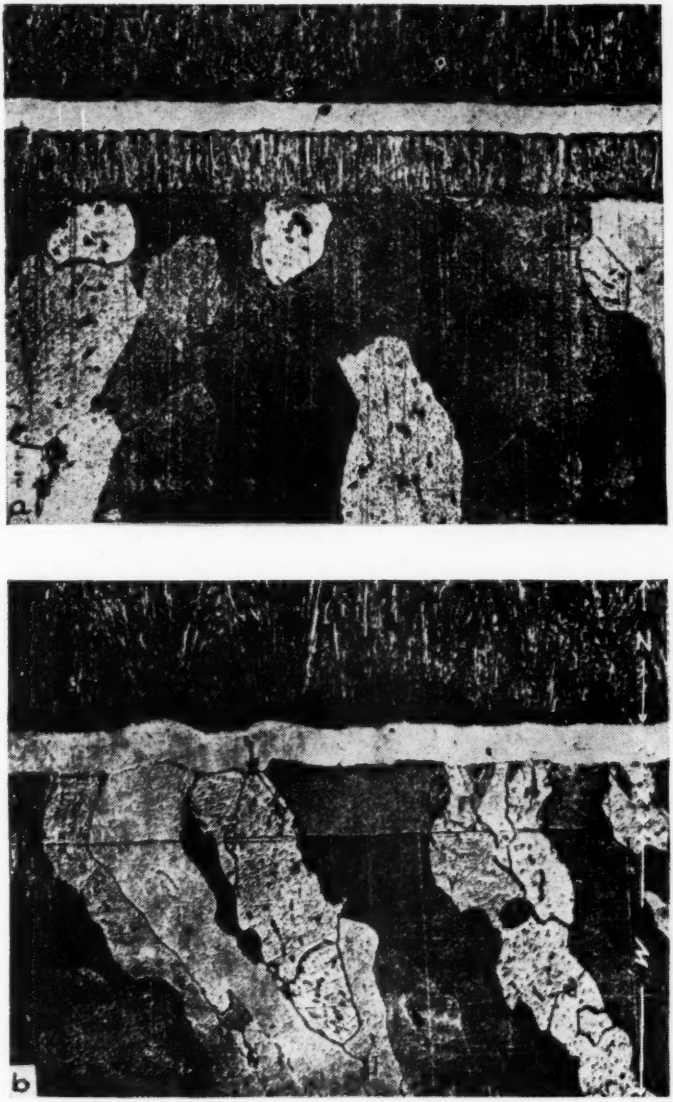

Fig. 2. Section of the chilled side of a "pig" of cast copper, upon which copper was elctrolytically deposited. x 100.

(a), the surface was cleaned but not pickled, prior to the electodeposition.

(b), the surface was pickled after cleaning.

The various zones indicated in "b" are the same throughout all of the micrographs: w, base metal; x, electrodeposited copper (first layer); y, electrodeposited nickel; z, electrodeposited copper (second layer).

a

x 130 H_2O_2 . NH_4OH

b

x 130 H_2O_2 . NH_4OH

Fig. 3

Copper deposit on annealed copper sheet. Current 1 amp. per sq. dm. (a) Showing reproduction of large grains. (b) Showing large grained structure of the deposit. Both deeply etched.

crystal structure of base metal into the deposit. Some of these are reproduced in Fig. 3.

The following remarks are taken from the discussion of the above paper by Graham:

Wm. Blum: "Such a distinction as Mr. Graham has made may be useful, even though it is not sharply defined. The general principles of crystal growth will probably determine the relation of the structure of any layers to those previously deposited, regardless of whether or not the initial layers owe their structure to that of the underlying base metal.

C. P. Madsen: "I do not agree with Mr. Graham's conclusions because two considerations have not been taken into account. First, he has omitted making deposits on ferrous metals; second, he has omitted nickel.

"In his first conclusion he says, 'Reproduction, therefore, does not depend so much on the preliminary chemical treatment as on the state of the metallic surface.' I think neither is correct. My opinion is that when the work is completed it will sum up something like this: that any electrodeposit tends to copy the structure of any metal. Whether it does so or not depends upon the condition of the metal surface and whether it has been cleaned by chemical or mechanical means.

"Furthermore, Mr. Graham is not justified in drawing a conclusion that the reproduction or tendency to reproduce the base metal structure is always undesirable. It may be desirable, for instance, to deposit a copper surface which copies the fine structure of a rolled copper base. On the other hand, it may safely be said that it is always undesirable for a nickel deposit to copy the structure of any metal other than nickel upon which it is deposited, because the natural structure of a pure nickel deposit is so fine that its hardness and tensile strength may be even greater than that of the best tool steel obtainable. Therefore, if the strength of electrodeposited metal is a function of the structure, as it is in metals made by melting, it is undesirable that nickel copy the structure of metals which are not as strong and hard as the best nickel structure obtainable electrolytically.

A. Kenneth Graham (communicated): "Replying to Mr. Madsen's remarks, deposits of nickel were studied; iron was not. I fail to see what bearing this has on the results stated in the paper.

"The statement that 'Reproduction does not depend so much on the preliminary chemical treatment as on the state of the metallic surface' is not an attempt to explain the mechanism of the observed phenomena. It is merely a contradiction of a statement made in a previous article to the effect that reproduction was obtained if the cathode (copper) were taken from a nitric acid dip into the plating bath, but not if taken directly from an alkaline (cleaning) solution.

"Regarding the last statement, I am unaware of making any statement to the effect that reproduction is undesirable. On the contrary, I would be tempted to believe that reproduction would cause greater adhesion of the deposit, with resultant advantages in cases of wear and friction, etc."

Instances of continuation of the crystal structure of the base metal into the deposited metal are very limited and many contend that such microphotographs have been misinterpreted. Additional evidence which appears conclusive is submitted by Hothersall.[94] He refers to the articles by Blum and Graham and an earlier article by himself in which some skepticism is expressed. He claims now, however, to have shown that this phenomenon is not limited to metals of the same crystal system, but can also occur with metals of different crystal systems. He states:

"It has been suggested by workers in other fields that the evidence of such photomicrographs as Fig. 1 (*our Fig. 4*) falsely suggest a continuation of structure, but an X-ray examination made at Woolwich of several selected large crystals in a piece of cast copper showed an identical single crystal pattern both before and after deposition of a substantial thickness (about .01 inch) of copper.

"The fact that continuation of microstructure has only been demonstrable with a limited number of electrodeposits is easily explained. For success with this method, it is essential that there should be little hindrance to the continued growth of

(*Continued on page* 1018)

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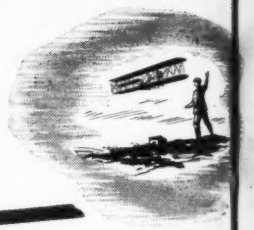

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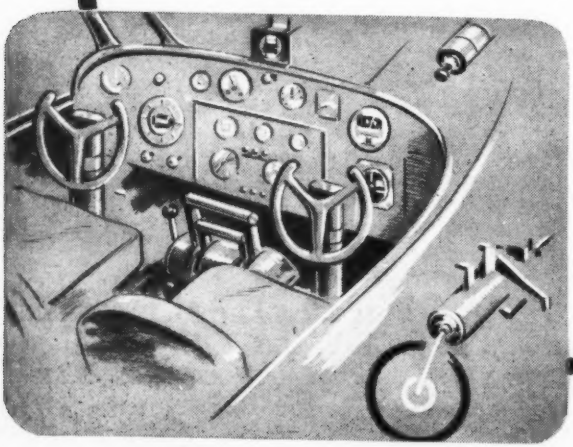

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ADHESION OF ELECTRODEPOSITS

(*Continued from page* 1015)

Copper deposit—Upper Annealed silver—Lower

Fig. 4. Continuation of microstructure of annealed silver by electrodeposited copper.

a single crystal of the electrodeposit. A pure acid copper sulphate bath is suitable since this condition is fulfilled at low current densities. With nickel deposits, however, it has been found that, even under the most favorable conditions of deposition, non-metallic matter is included with the deposit to a sufficient extent to interfere with the continued growth of a given crystal. The growth of large grains is thus prevented and continuation of the structure of the basis metal cannot usually be seen under the microscope.

"It can, however, be shown indirectly that such continuation does occur over small thicknesses. Thus, a sample of annealed electrolytic iron was cleaned by degreasing and etching anodically, in sulphuric acid and a thin layer of nickel (approx. 10^{-5} inch in thickness) was deposited under conditions which yielded maximum grain size, (Watts' type single salt bath, 35°C., 5 amp. per sq. ft., pH 5.4) followed by a thick coating of copper from a pure acid copper sulphate solution at 35°C. with low current density (5 amp. per sq. ft.). The microstructure of the iron (body centered cubic system) was copied by the copper deposit (see Fig. 2) (*our Fig. 5*) as already indicated, this implies that the orientation of the grains in the copper and iron are similar and therefore presumably in the intermediate nickel deposit also. When a thick nickel deposit was formed on a similar piece of electrolytic iron, it was found to have a columnar microstructure and it is suggested that, as the deposit grew, the orientation, initially copied from the iron base, gradually changed owing to the interference of foreign matter included in the deposit until, within a relatively small distance from the base, the deposit assumed the normal habit of electrodeposited nickel (i.e. with the majority of cube faces approximately parallel to the plane of the deposit). The greater the interference, i.e., the smaller the grain size, the more quickly is the orientation influence of the base likely to disappear. The results briefly reviewed above and the conclusions drawn from them indicate, therefore, that when nickel is deposited on a clean, etched surface of pure iron, it follows for a time the orientation of the crystal lattice of the iron and that the two metals are held together by atomic forces. With metals of commercial purity the evidence of adhesive forces, approaching or exceeding the tensile strength of the metal, suggests that this type of bond-

ing applies generally to electrodeposits of nickel on clean surfaces."

The most recent developments in this field have been made by C. D. Faust in connection with his work on electropolishing. In a recent paper (unpublished) he states:

"Thus, after electropolishing, the basis metal presents its true crystal structure to the depositing metal in the subsequent plating process. The plated metal can then continue the crystals of the basis metal as well as the crystal habits of the two metals will permit. A metal-to-metal bond is realized in which the atomic forces provide the adhesion. Better bond strength than that which results, cannot be obtained. The inter-atomic forces determine the strength of any metal, and it is the full operation of these that define the best bond strength that can be obtained in plated metals."

Polished Versus Etched Surfaces for Better Bonding

Another highly controversial topic relative to bond strength has to do with the smoothness of the surface of the base metal. Many argue with much feeling that a more or less roughened or etched surface gives the best bond, and considerable evidence is available in support of this view. Many others argue with equal energy that the smoother the surface the better the bond. The former point of view is well-expressed by R. J. Piersol.[47] His statements follow:

"In plating nickel on metallic aluminum, it is quite essential to etch the surface. Aluminum is subject to almost instant oxidation in the form of a very thin transparent film of aluminum oxide. Since the oxide surface is more resistant to etching than non-oxidized aluminum, which is exposed when once the surface is punctured, microscopic examination reveals the etched surface to appear as shown in Fig. IA (*our Fig. 6A*). Due to throwing power of a bath, such as nickel, the cavities are plated, resulting in a strong interlocking action so that the mechanical holding force of the plate to the foundation is of strength equal to the cohesive (tensile) strength of the deposited nickel.

"Instead of deep etching, an extremely fine surface etching may occur. The microscopic appearance of the boundary is shown in Fig. 1B (*our Fig. 6B*). Since the strength of adhesion is dependent on the force per unit area, perpendicular to the plane of contact, necessary to pull the surface apart, it is evident that the effective strength of adhesion will be increased in proportion to

Copper backing—Upper — Thin nickel deposit—(not visible)
Copper deposit—Center — Electrolytic iron annealed—Lower

Fig. 5. Continuation of microstructure of annealed iron by electrodeposited nickel and copper.

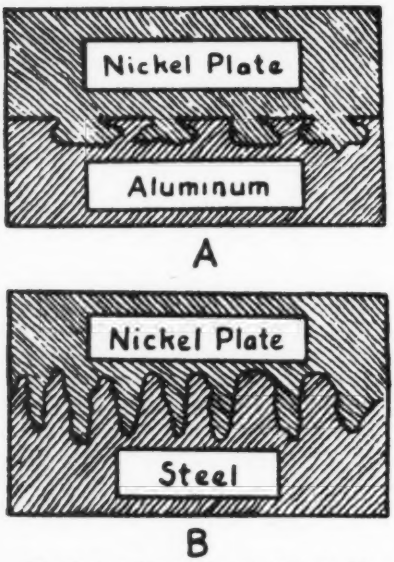


Fig. 6-A—Illustrating the interlocking action of nickel plate on aluminum. B—Boundary appearance of nickel plate applied to finely etched steel surface.

the surface area of contact. In terms of atomic surface area of contact, surface etching may increase the effective contact area from two to four times."

The opinions of H. L. Crosby and L. I. Gilbertson are summarized in the abstract of their article.[116]

"Photomicrographic examination of silver electrodeposited on steel indicates that the adherence of silver to steel is dependent on factors other than mechanical interlocking. Evidence indicates that the strike produces crystal nuclei at the edges of ferrite crystals and that the columnar, usually twinned, crystals which are plated on silver-struck steel grow from these nuclei. It appears that the most important factor in the bond between silver and steel is the intra-atomic bond between closely associated crystals of ferrite and silver and that this condition is favored by the use of a silver strike before plating. Previous reports that a strike is essential to the best adherence are confirmed."

In an early article (1933) by Hothersall,[43] the statement is made:

"The suggestion that mechanical interlocking is capable of giving rise to any appreciable adhesion is not supported by experimental results which on the contrary tend to negative the possibility of such a mechanism."

In a discussion of this paper[43] Blum has this to say in part:

"On page 6, paragraph 5, the author, Hothersall, discredits the beneficial effect of 'mechanical interlocking,' although all the researches on the plating of aluminum have shown the need for such interlocking to obtain even moderate adhesion. Would it not be more correct to say that if there is real atomic adhesion (i.e. cohesion), roughening cannot increase the bond; but when passive films are present, as on aluminum no appreciable adhesion is possible except by interlocking."

In a later paper[94] (1939) Hothersall provides the following statements and data:

"Suggestions have frequently been made that a mechanical interlocking of the deposit and base is responsible partly at least, for the adhesion of an electrodeposited metal. There is no doubt that mechanical interlocking can occur and that it can cause deposits to adhere when they might otherwise peel or flake, especially when they are of the order of thickness normally applied in decorative plating. It is, however, considered that mechanical interlocking can, at best, only contribute a small amount to the strength of the bond which can exist between many electrodeposits and the metals to which they have been applied. The author has obtained high adhesion results on polished surfaces which were only given a very light etching treatment, insufficient to dull the polish perceptibly. Examples are shown in Table II.

TABLE II

ADHESION OF ELECTRODEPOSITED NICKEL TO POLISHED (BUFFED) METALS

Metal	*Adhesion lb./sq. in.*
Mild Steel	37,000; 44,000; 37,000
0.5% Carbon Steel	48,000; 44,900
1% Carbon Steel	35,000; 34,000; 43,000
Copper	38,000; 39,000
Brass	47,000; 46,000

"These results cannot be explained by mechanical interlocking. On the contrary, an explanation involving some form of 'atomic bonding' is necessary."

In connection with his recent work on electropolishing, Faust has shown that a steel surface cleaned in this manner, which is the smoothest kind of a surface, or by mild mechanical means, such as used by a metallographer, gives a bond with electrodeposited nickel having a tensile strength of 90,000 p.s.i. as measured by the Ollard method which is the same as that of nickel or nearly that of the steel. Under corresponding conditions except without the electropolish, the bond strength was only 35,000 p.s.i. Microscopic examination showed that the failure in the latter case was due to a weak surface layer in the steel. The electropolish removed this weak layer, and thus about doubled the measured bond strength.

F. C. Mesle[96] makes the following remarks:

"It is generally assumed that the smoother the surface the more difficult it is to get an adherence of the deposit. Frequently, an acid dip is suggested to etch the surface to give the plate a chance for anchorage. This seems very logical if plating is held by a mechanical bond, and no doubt some plating is. But when this is so, the plating at best is poorly adherent. It is my experience that a perfectly adherent deposit can be plated on the most highly finished surface. In fact, under the same cleaning conditions, the adherence is better on the highly finished surface than on an emeried, brushed or satin finished surface.

"In making comparisons of the degree of adherence of any metal plated with any metal, I have found that the adherence is seldom better on the rough surfaces and many times the adherence was better on the smooth or highly buffed surface."

Extensive experimental evidence is contained in this paper by Mesle to demonstrate that the smoothest surface, irrespective of the base metal or deposited metal provides the strongest bond.

E. A. Ollard[14] offers the following observation:

"In this connection the action of the pickling bath is interesting as it is difficult to see why so much better results are obtained by this method than by others. The first action of the bath is probably to remove all surplus matter and expose the crystal structure, after which the work goes passive and gases.

"It is worth noticing that it has been found that if an electrodeposit is made on a carefully pickled metal its structure may follow that of the base. (A. K. Huntington, Trans. Faraday Soc. 1, 324 (1915); Blum and Rawdon, Trans. Electrochem. Soc. 44, 305 (1923). This seems to show that the crystals of the base metal exert some effect on those of the deposit.

"It is now questionable whether the adhesion can be due to the keying action of the nickel into the pickled base, or whether it is caused by the cohesion between the crystals of the two metals. From a microscopic examination it does not seem probable that this action would be sufficient to account for the observed effects. It must, therefore, be ascribed to the cohesion between the crystals of the two metals, though whether this is due to molecular attraction, inter-mingling of the space lattices, or an inter-crystalline cement, can only be decided by the physicist. It seems probable, however, that if a crystal of deposit can be grown direct on to one of the base metals, the two will adhere in the same way and with forces of the same order as the crystals of solid metal."

In support of the etching treatment in order to secure better adhesion, R. Yates,[98] makes the following statement:

"In every instance where aluminum was plated without preliminary treatment of etching, the results were very sad indeed, and no record has ever been made of commercially acceptable adhesion being produced in any instance. Until about two years ago it was generally conceded, that there was no acceptable method of plating aluminum in the sense that other metals are plated."

Many more statements might be quoted concerning this topic, but enough have already been given to show the conflicting experimental evidence and the attitudes taken by authorities on the subject.

There are numerous other factors of a general nature which might well be considered in any treatment of adhesion, but no more will be discussed here. Some will be taken up in connection with the major topic of this paper which has to do with methods for measuring the degree of adhesion of electrodeposited metals on a base metal.

HIGH SPEED ZINC PLATING

By A. E. CARLSON and M. J. KRANE

General Chemical Company, New York, N. Y.

WITH the improvements in high speed continuous plating equipment of recent years, electrodeposited zinc is assuming greater importance for strip applications. The uniformity of both finish and quality and more positive control of coating thicknesses, which are possible with the electrolytic process, offer advantages over the hot dipping method. The high current efficiency, high limiting current densities and low resistivity of improved modern electrolytic acid processes favor high speed production and lowered operating costs.

Previous investigations of lead, nickel, copper and other metal fluoborates had indicated that, in addition to other desirable characteristics, baths of fluoborate electrolytes possessed promising high speed plating possibilities. Further exploration of the zinc compound has resulted in the development of a bath which offers new advantages, both in the high speed continuous and in still tank plating applications.

The metal fluoborate plating baths generally have the following advantages:

1. Simplicity of preparation of bath from the concentrate,
2. Stability of the bath composition,
3. Ease of control,
4. Operation at or near room temperature,
5. Practically 100% anode and cathode efficiency,
6. Fine-grained deposits of good color.

The zinc fluoborate bath in particular shows the following advantages:

1. In high speed plating, zinc may be deposited at a rate higher than other commonly used acid baths.
2. In tank and barrel plating, zinc may be readily deposited on cast or malle-

Fig. 1. Typical Iron Castings. Top: Before plating. Bottom: After plating in zinc fluoborate solution.

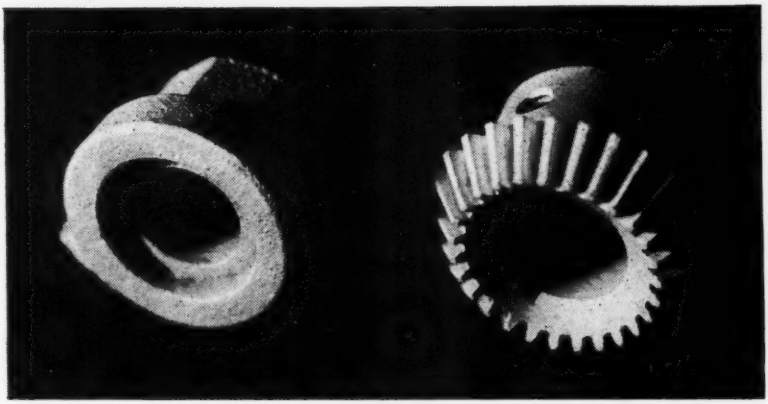


Fig. 2. Iron castings plated in zinc fluoborate bath.

able iron to give good adhesion, a uniform coverage and an attractive, light colored finish, a job which has proven rather unsatisfactory with the alkaline baths.

Figures 1 and 2 show typical iron castings that have been plated from the zinc fluoborate bath. Figure 1 provides a comparison of the castings before and after plating. These parts were processed as follows:

1. Tumbled with abrasive
2. Tumbled with leather
3. Racked
4. Alkali cleaned
5. Rinsed
6. Acid dipped in 9% HCl containing 1% HF at 140°F. for one minute.
7. Rinsed
8. Plated at current density of 50 a/sf to a thickness of .0005 inch
9. Rinsed in cold and hot water and dried.

Physical and Chemical Properties

Zinc fluoborate, a comparatively new chemical in the modern electroplating field, is available as a clear, colorless liquid, having a specific gravity of about 1.55. Zinc fluoborate, like the other metal fluoborates, is marketed in the form of a "concentrate," a solution containing about 50% zinc fluoborate and 3% free boric acid. The "concentrate" has a pH of 3.0, which is close to the desired operating range of the plating baths. It can be diluted directly with water to any desired concentration.

Preparation of Bath

For high speed plating, such as is required in continuous wire, strip or sheet applications, the following bath composition has been found satisfactory:

	g/l	*oz./gal.*
Zinc Fluoborate, $Zn(BF_4)_2$	300	40.2
Ammonium Chloride, NH_4Cl	27	3.6
Ammonium Fluoborate, NH_4BF_4	35	4.7
Licorice	1	.134

The bath may be more dilute for tank plating and barrel plating, and modified slightly, as follows:

	g/l	*oz./gal.*
Zinc Fluoborate	200	26.8
Ammonium Chloride	54	7.2
Ammonium Fluoborate	35	4.7
Licorice	1	.134
or Karo	80	10.7

To make up a bath, the concentrate is diluted with water in the ratio of 1 volume of concentrate to approximately 1¼ to 2¾ volumes of water, as is necessary to give the desired metal content. The desired amounts of ammonium chloride and ammonium fluoborate are then added, the pH adjusted, and the addition agent introduced.

A pH range of 3.5-4.0, determined colorimetrically, has been found satisfactory for plating zinc from the fluoborate bath. The pH of the bath may be raised by the addition of zinc carbonate, or lowered by the addition of fluoboric acid. During the addition of zinc carbonate, the bath should be vigorously agitated.

Addition Agents

Of a number of addition agents tried, excellent results have been obtained with licorice, at a concentration of about 1 g/l, or glucose at a concentration of 80 g/l. The amount of addition agent may be varied as the type of deposit dictates. A fine-grained, white deposit is obtained when using the amounts specified. Licorice is preferable in high speed plating because of the lower resistivity of the resulting solution. For low current density plating, Karo is preferable as it improves the covering power and gives a smoother, finer-grained deposit.

Operating Conditions

Optimum operating temperatures are from 80°F. to 130°F. Low temperatures tend to increase the throwing power. In tank and barrel plating, where low current densities are used, temperatures in the range of 80°-100°F. are satisfactory. However, in high speed baths, involving high current densities and high metal concentration, a temperature of about 130°F. is recommended. The higher temperature lowers the resistivity of the bath appreciably, as shown in Table I. The specific resistance of the 300 g/l bath described herein is 6.2 ohms per cubic centimeter at a temperature of 80°F., while at 130°F. it is reduced to 4.4 ohms per cubic centimeter. This lowering of the specific resistance is an important economic factor affecting the power cost in continuous, high speed applications.

As is indicated in Table I, temperature is the greatest factor affecting specific resistance, the pH of the bath, concentration of zinc, or the addition of ammonium fluoborate having no appreciable effect.

Increasing the temperature to 130°F. also increases the maximum current densities obtainable. In still tank plating, current densities of 25-100 amp./sq. ft. have given excellent deposits. However, in high speed plating, where a high production capacity is important, much higher current densities are necessary. The limits of current density obtainable under various conditions of temperature and bath concentration are shown in Table II. An increase in the zinc content of the bath, as well as an increase in temperature, permits the use of higher current densities. The pH of the bath has no appreciable effect on the limiting current density.

Table II also shows the effect of ammonium fluoborate on the limiting current density of the bath. The 300 g/l bath described herein, operating at 130°F. without agitation, has a limiting current density of about 530 amp./sq. ft. when no ammonium fluoborate is present. The addition of 35 g/l of ammonium fluoborate raises the limiting current density to about 800 amp./

TABLE I

EFFECT OF TEMPERATURE ON SPECIFIC RESISTANCE

$Zn(BF_4)_2$ g/l	pH	Temp. °F.	Spec. Res. ohm/cm³.	NH_4Cl g/l	NH_4BF_4 g/l
200	3.5	80	6.2	54	—
"	3.5	105	4.8	"	—
"	3.5	130	4.3	"	—
"	4.5	80	6.3	"	—
"	4.5	105	4.9	"	—
"	4.5	130	4.3	"	—
"	4.0	80	6.3	"	60
300	4.5	80	6.3	27	—
"	4.5	105	5.5	"	—
"	4.5	130	4.4	"	—
"	4.0	80	6.2	"	35
"	4.0	130	4.4	"	35

TABLE II

EFFECT OF TEMPERATURE AND CONCENTRATION ON LIMITING CURRENT DENSITY

(BATH NOT AGITATED)

$Zn(BF_4)_2$ g/l	pH	Temp. °F.	Current Density amp./sq. ft.	NH_4Cl g/l	NH_4BF_4 g/l
200	3.5	105	250	54	—
"	3.5	130	380	"	—
"	4.5	105	250	"	—
"	4.5	130	380	"	—
300	3.5	105	350	27	—
"	3.5	130	530	"	—
"	4.5	105	350	"	—
"	4.5	130	530	"	—
"	3.5	80	530	"	35
"	3.5	130	800	"	"
"	4.0	80	530	"	"
"	4.0	130	800	"	"
"	4.5	80	530	"	"
"	4.5	130	800	"	"

sq. ft. Agitation of the bath will raise the limiting current density to a much higher figure.

A comparison of the limiting current density of the zinc fluoborate bath with that of other common high speed zinc baths is shown in Table III.

TABLE III

LIMITING CURRENT DENSITY OF VARIOUS BATHS

COMPARED AT 130°F., WITHOUT AGITATION

	Limiting Current Density amp./sq. ft.
Fluoborates	800
Sulfate	400
Chloride	300

The anodes should be pure zinc for best results. In tank plating the anode area should be about twice the cathode area. In high speed continuous plating applications the anode area should be about equal to the cathode area and larger if possible.

In high speed plating, the specific resistance of the bath is an important economic factor, not only due to its effect on power consumption, but also because of the cost and size of installation that may be necessary to provide adequate cooling of the bath.

A comparison of the specific resistance of the zinc fluoborate bath with that of other common high speed zinc baths is shown in Table IV.

TABLE IV

SPECIFIC RESISTANCE OF VARIOUS BATHS

COMPARED AT 80°F.

	Specific Resistance
Fluoborate	6.2 ohms/cm.^{3}
Sulfate	13.0 "
Chloride-Acetate	12.0 "
Chloride	4.0 "

The composition of the various baths upon which the above limiting current density and specific resistance figures are based is shown in Table V.

TABLE V

COMPOSITION OF VARIOUS BATHS

	Fluoborate g/l	Sulfate g/l	Chloride g/l
$Zn(BF_4)_2$	300	—	—
$ZnSO_4.7H_2O$	—	240	—
$ZnCl_2$	—	—	270
NH_4Cl	27	15	225
NH_4BF_4	35	—	—
$AlCl_3$	—	—	15
$Al_2(SO_4)_3 \cdot 18H_2O$	—	30	—

TABLE VI

RATE OF ZINC DEPOSITION FROM THE ZINC FLUOBORATE BATH

(99% Cathode Efficiency)

Thickness in Inches	.0001	.0005	.001
Oz./Sq. Ft.	.059	.295	.59
Amp./Sq. Ft.	Time in Minutes		
25	3.4	17.2	34.3
50	1.7	8.6	17.2
100	.8	4.3	8.6
200	.4	2.2	4.3
400	.2	1.1	2.2
800	.1	.6	1.1

The current efficiency of the zinc fluoborate bath is very high, running about 99% cathode efficiency over the entire range of temperature and current densities investigated. The anode efficiency is also about 100%.

The accompanying Table VI shows the rate of zinc deposition from the zinc fluoborate bath.

Control of Bath

The bath is controlled by checking the zinc metal, the ammonium chloride and the ammonium fluoborate contents, the pH and the concentration of the addition agent. The pH may be controlled colorimetrically, using brom-cresol green indicator or an indicating pH paper. Electrometric pH readings with the glass electrode are unreliable since the electrode is affected by the fluoborates. Quinhydrone pH measurements must be made with a saturated sodium chloride salt bridge between the plating bath and saturated potassium chloride calomel electrode, since otherwise potassium fluoborate precipitates cause faulty readings.

The addition agents are most satisfactorily controlled by separate small cell tests. A small amount of the bath is tested with added amounts of licorice or Karo until the desired type of deposit is obtained. A proportionate amount of addition agent is then added to the plating bath.

Analytical Procedures

The following analytical procedures are used to determine zinc, ammonium chloride and ammonium fluoborate contents of the plating bath:

Zinc. A 5 cc. sample of the plating bath is diluted with 100 cc. of water in a 250 cc. beaker. The solution is made acid by the addition of 2 cc. of concentrated hydrochloric acid. The solution is then titrated cold with standard potassium ferrocyanide solution, 22 g/l $K_4Fe(CN_6)$, using a 5% uranium acetate solution on a spot plate as an outside indicator, taking the light brown endpoint.

cc. standard potassium ferrocyanide = g/l zinc.

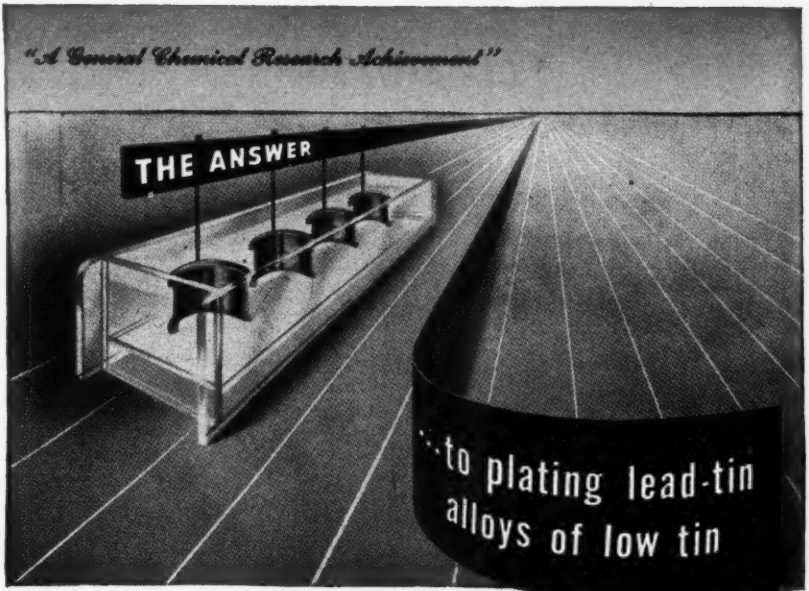
Ammonium Chloride. A 5 cc. sample of the plating bath is diluted with 100 cc. of water in a 250 cc. casserole. After adding 1 cc. of a 2% sodium chromate solution, the solution is titrated with .1 N silver nitrate solution to a slightly reddish endpoint.

cc. .1 N silver nitrate x 1.07 = g/l ammonium chloride.

Ammonium Fluoborate. A 10 cc. sample of the plating bath is introduced into an ammonia distillation apparatus. Approximately 50 cc. of water and 50 cc. of a 20% sodium hydroxide solution are added. The ammonia is then distilled off and collected in 100 cc. of saturated boric acid solution. The ammonium borate is titrated with .5 N hydrochloric acid, using methyl orange indicator.

cc. .5 N hydrochloric acid x .85 = g/l ammonia

$[g/l\ NH_3 - (g/l\ NH_4Cl \times .3183)] \times 6.154 = g/l$ *ammonium fluoborate.*



For more than 25 years metal finishers have sought a successful means of plating lead-tin alloys in the low tin ranges. "Not feasible . . . inoperable . . . too many variables," read published reports on method after method.

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A Miniature Laboratory Fume Eradicator

By G. FREDERICK SMITH

Department of Chemistry, University of Illinois, Urbana, Ill.

THE most convenient and practical laboratory equipment for use with reactions which are accompanied by the production of corrosive, poisonous or noxious fumes, is a fume hood provided with an efficient forced draft ventilation system. Such equipment is not universally available. The described assemblage of apparatus is proposed as a substitute for this equipment.

The various pieces of apparatus are, as far as possible, stock items which may be purchased from any well stocked chemical supply house. The assembly is shown in Figure 1.

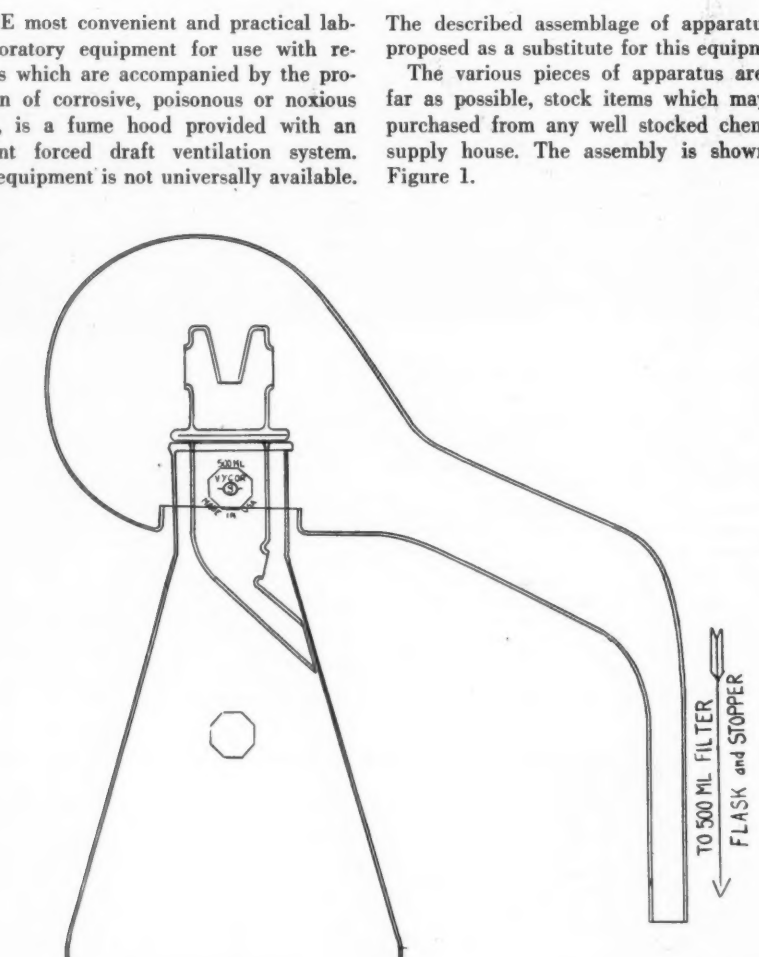

Fig. 1—Reaction vessel, reflux still head, and fume extraction chamber.

A 500 ml. Vycor flask serves as the reaction vessel. A pyrex flask of the same type may be used. The Vycor flask is much more convenient because its contents may be heated without special care and cooled in the flask from any reasonable temperature, including that of boiling conc. sulphuric acid (abt. 360°C.), by immediate immersion in an ice and water bath. Fear of cracking due to thermal shock is entirely eliminated. This is an important advantage if one is to use hot concentrated sulfuric acid or evaporate a sulphuric acid solution to fumes. The flask may be placed while wet directly upon a preheated hot plate or from the hot plate at once upon a cold metal or stone topped laboratory bench. Flasks which are moist inside may be dried in a few minutes by placing them on the hot plate until hot and dry and then removed and cooled by a stream of tap water on the outer walls. Much time is thus saved if one compares necessary precautionary manipulations using pyrex flasks.

To avoid loss by spray a reflux still head is inserted in the mouth of the reaction flask. It is made of pyrex tubing of 25 mm. outside diameter with a flange of 37 mm. outside diameter formed 30 mm. below the top. At 70 mm. below the top the tube is constricted to 9 mm. outside diameter with the lower extremity ground to a bevel to contact the side wall of the 500 ml. Erlenmeyer Vycor flask. A vent hole 8 mm. in diameter is provided as shown on the lower extremity.

Two side vents 10 mm. wide shown at the top provide openings also for rinsing the inside of the refluxing still head. A funnel shaped opening at the top 13 mm. wide tapering to a 5 mm. opening at the bottom extends 17 mm. down to the bottom level of the two side vents. The refluxing still head besides preventing loss by spray and spattering also serves to reflux evolved acid fumes back into the reaction vessel to an extent regulated by the applied temperature.

The principal remaining portion of the assembly is the modified 500 ml. pyrex Kjeldahl flask used as the fume extraction chamber shown in Figure 1. A 45 mm. opening in the side of the bulb, with the center of the opening 65 mm. from the bottom of the flask, has an 8 mm. inside flare to prevent any condensate collecting on its inside walls being emitted at the opening. The neck is constricted to 12 mm. and an 130-140 mm. long adapter tube is attached and bent at an angle of 120 degrees to the neck of the flask. This exhaust hood is inserted by means of a rubber stopper into a 500 ml. suction flask containing 300 ml. of dilute caustic soda to absorb evolved acid vapors.*

A photograph of the assembled apparatus in use is shown in Figure 2. A metal aspirator of the familiar type used for reduced pressure filtrations may be employed to displace the fumes from the flask.

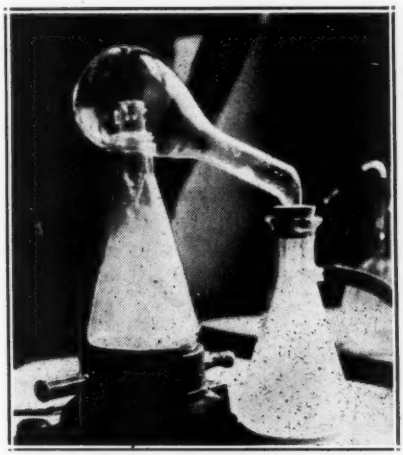

Fig. 2
Assembled apparatus.

The apparatus has been used for such operations as those previously noted as well as many others involving noxious fumes such as the destruction of organic matter in blood, urine, feeds, chromacized catgut sutures, leather, etc. The assembly may be used for the displacement of hydrocyanic acid from acidified cyanide solutions.

Until the refluxing still heads and the modified Kjeldahl aspirating flasks are made otherwise available they may be purchased from the G. Frederick Smith Chemical Company, 867 McKinley Ave., Columbus, Ohio.

*Editor's Note:—The completeness of such absorption naturally requires that the rate at which the gas to be absorbed is evolved is not too rapid.

CARE OF FIRE EXTINGUISHERS

Safety Research Institute, Inc.

New York City

HAND fire extinguishers must be kept ready for instant use or they may fail to operate properly when needed. To maintain them in good working order, they must be inspected frequently, refilled immediately after use, and thoroughly serviced at least once a year.

Inexperienced men should be supervised to assure correct treatment and reassembly of each extinguisher. In no case should so many extinguishers be removed for servicing at the same time as to leave any area without protection.

Soda acid and foam extinguishers must be recharged annually, if they have not been used and refilled in the meantime. Other types are recharged only after use. The tag attached to each extinguisher should show the last date of recharging or annual servicing. Only replacement parts or recharging materials made by the manufacturer of the extinguisher being serviced should be used.

The servicing procedure for each type is as follows:

Vaporizing Liquid: Test the action by pumping some of the contents into a clean, dry container, and return the discharged liquid. In the case of the pump-gun types, add more liquid, if necessary, to bring the level to within half an inch of the top. In servicing the stored pressure type, bring the liquid to the proper level and replenish the air pressure.

Never recharge a vaporizing liquid extinguisher with ordinary carbon tetrachloride or use water to test operation, as either will cause corrosion. Do not lubricate any part of the extinguisher.

Soda Acid: Be sure the nozzle opening is clear; then invert the extinguisher and discharge the contents. Unscrew the head and examine the gasket, which should be replaced if it is damaged or badly worn. Remove the cage containing the acid bottle, putting aside the stopple for later replacement. Make sure all the extinguisher parts are kept together so that they may later be returned to their respective units.

Rinse the extinguisher shell thoroughly with warm water, draining it through the hose. Open clogged holes in the hose strainer with a piece of wire. Replace the hose and nozzle, if badly worn or damaged.

Dissolve the dry chemical in lukewarm water, according to directions on the recharge package. Pour the solution into the extinguisher shell, and bring to the filling mark by adding water. Remove the cork from the new acid bottle and replace it with the stopple from the old bottle. Replace bottle and cage in the extinguisher neck. (If any acid spills on the skin or clothing, wash it off with water.) Rub a little vaseline on the shell threads and replace the head, using only hand power. Be sure that the gasket fits snugly against the shell neck.

CAUTION: If the extinguisher looks badly dented, or the seams appear weakened, no not discharge. Instead, remove the head and pour out the contents. Return to the manufacturer or his agent for repair.

Foam: As in the case of the soda acid, discharge by inverting. Remove the head and lift out the inner tank. Rinse the extinguisher thoroughly, draining water out through the hose. Dissolve the charging material according to instructions on the packages, using hot water for the A charge and lukewarm water for the B charge. Pour solution A into the inner cylinder and solution B into the outer tank, bringing both up to the filling marks by adding water. Replace the stopple on the inner tank and return it to the extinguisher shell. Replace the head, as for the soda acid.

Loaded Stream and *Gas Cartridge:* Since these types operate by gas released from a

(*Continued on page* 1059)

Acid-proof TILE LININGS FOR CHROMIUM PLATING TANKS

Chrome plating authorities generally agree that acid-proof tile or brick-lined steel shells make not only the best but the least expensive chrome plating tanks.

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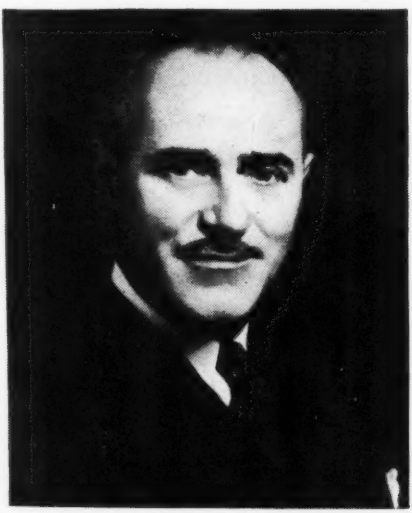
INDUSTRY NEWS

Wanted

Slightly used or good condition 25 Packer Automatic machines, state age, type and serial number. Jackson Buff Corporation, 21-03 41st Avenue, Long Island City, N. Y.

New Sales Director for Egyptian Lacquer

Hugh C. Crawford, recently appointed Director of Sales for The Egyptian Lacquer Mfg. Co., Rockefeller Center, manufacturers of Specialized Production Finishes for industrial users. During the past three years, Mr. Crawford has headed the War Production Division of the Company. The announcement was made by O. J. S. deBrun, president of The Egyptian Lacquer Mfg. Co.



New Address for Michigan Bleach & Chemical

Michigan Bleach & Chemical Company announced, effective September 1, 1945, the removal of their plant and offices to new and larger quarters located at 12345 Schaefer Highway, Detroit 27, Mich.

Plating Business Activity in New York City Area

According to the August issue of the *Monthly Bulletin of the Masters' Electroplating Association*, "the rate of operation among the members for August was 68½% compared with 70% for July." Continuing further this note states: "Just before V-J Day, it was 67%. It will be remembered from the last Bulletin that the figure 71% is equivalent to 85% according to the previous method of calculation. In other words, on our present basis of calculation the rate of operations in August, 1944 was 73%. It will be seen therefore, that the rate of operations has begun to decline. Moreover, in view of the fact that V-J Day has arrived, it is probable that the rate of operations for next month will show an even greater falling off."

Diversey Enlarges Field Service Staff

The Metal Industries Department of The Diversey Corporation announces that it has added three new men to its field service staff. They are R. B. Petty, C. G. Smith, and W. R. Graham-Smith.

R. B. Petty will cover the Los Angeles

area, C. G. Smith will headquarter at Fort Wayne, Ind., and W. R. Graham-Smith has been assigned a territory in Canada. These men will promote and service Diversey products and processes for metal cleaning and working operations.

Welding Society Honors Deppeler

J. H. Deppler, chief engineer of the Metal and Thermit Corporation, New York, N. Y., has been selected by the American Welding Society to receive the Miller Award for outstanding work contributing to the art of welding. Established in 1927 by S. W. Miller, the ward is granted annually by the society.

Mr. Deppeler became affiliated with the Metal and Thermit Corporation in 1912. For some years he was superintendent of the Jersey City plant, later being appointed works manager and then chief engineer of the Corporation.

Among the activities of the company in which he took a leading part are the manufacture of metals by aluminum reduction; development of Thermit welding and chromium plating processes; development of Murex welding electrodes; production of incendiary Thermit, and the manufacture of titanium dioxide from rutile.

Mr. Deppeler is one of the founders of the American Welding Society and was its first vice-president. Later he was chosen president of the society, and, in the intervening years, he has served on many technical committees of this and other organizations.

Zapon Modernizing and Expanding Plant and Laboratory Facilities

Modernization and additions to plants and equipment, with a view to streamlining production of its regular peacetime products, will more than double the plant capacity of the Zapon Division of Atlas Powder Company, according to a recent announcement by J. K. Weidig, general manager.

These new additions to plant and equipment are estimated to cost several hundred thousand dollars, Mr. Weidig said. Development and evaluation laboratories also are being enlarged and modernized. The company's plants at Stamford, Conn., and North Chicago, Ill., are affected by this program.

Wesley Cassell Joins Lea

The Lea Manufacturing Company, Waterbury, Conn., has appointed Wesley L. Cassell to its Technical Sales Staff. He will bring to his new duties many years of experience in the technical phases of metal finishing.

New Products Available For Manufacturers

Nationwide extension of a new products service established for manufacturers on the west coast was announced August 1st by Edward P. Bishop, president of Edward P. Bishop and Associates, 4031 Goodwin Ave., Los Angeles 26, California. The service is designed to provide reconverting manufacturers with a variety of new products for post-war manufacture, and has been so successful since it was started six months ago, it is now being made available in all major industrial areas of the country. Under the Bishop system, inventors throughout the country are culled for new products which will fit into the specific manufacturing facilities of Bishop clients. Both established products, manufactured in the past but discontinued because of the war, and brand new products are available through this service.

H-VW-M Adds to Staff

The Hanson-Van Winkle-Munning Company, Matawan, New Jersey, announces the following appointments:

Robert E. Creamer who was formerly in the Laboratory in Matawan, and more recently Supervisor of Plating at the U. S. Naval Air Station in Quonset Point, R. I., has returned to the Company. Mr. Creamer has recently completed a training course in Matawan, and is assigned to the New England Territory.

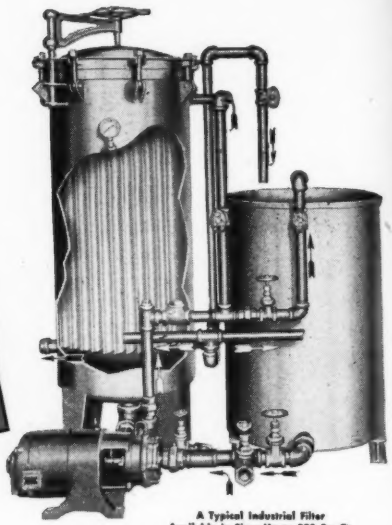
Richard E. Waite, recently in charge of plating and metal finishing at Stromberg-Carlson is now with H-VW-M. Mr. Waite received his technical training at the Rochester University of Technology and is widely experienced in the plating industry. He has completed a special training course at Matawan, and is now in the field, with headquarters at Landing Road S., Rochester, N. Y.

Lea Mfg. Co. to Distribute Manderscheid Accessories

The Manderscheid Company announces the appointment of Lea Mfg. Co. of Waterbury, Conn., as distributors of Presto Polishing Wheel Bushings, Semi-Automatic Tube Polishing Machines, Balance Ways and other Manderscheid Polishing Room accessories.

ASM Elects Lyman Metals Handbook Editor

The American Society For Metals announces that Dr. Taylor Lyman has been elected editor of the Metals Handbook and secretary of the Metals Handbook Committee. Dr. Lyman, previously a metallurgist with the Bendix Aviation Corp. was also a member of the teaching staff at Notre Dame.



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Available in Sizes Up to 390 Sq. Ft.
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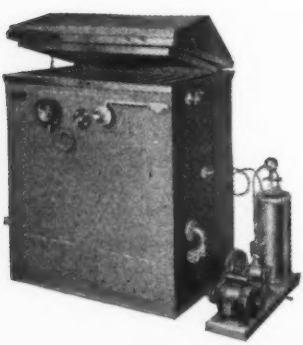
HERE IS GOOD NEWS FROM THE PLATING FRONT!

Industrial Plating Solution Filters are now coming equipped with AIRWASH — the new cleaning device that does a thorough job in a few minutes without opening the filter. You will welcome this new labor saving method of cleaning filters. The Industrial AIRWASH Device does a complete job of removing cake and sludge from filter cloths. There is no loss of time before starting the new filter cycle. Industrial Filters are furnished in sizes and models to fit your needs. Ask for our recommendations on the proper equipment to do your job better.



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Corrosion Test Equipment

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Serious rejection losses on industrial finishes which must meet Army or Navy specifications are avoided by systematic tests with Industrial Salt Fog Test Equipment.

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INDUSTRIAL FILTER & PUMP MFG. CO.

1621-25 WEST CARROLL AVENUE CHICAGO 12, ILLINOIS

June 12, 1945

Electrolytic Apparatus

U. S. #2,378,002. F. E. Drummond and D. E. Bench, assignors to The Himmel Bros. Co. An apparatus of the class described having a compartment containing an electrolyte, means for conducting and guiding a preformed structural member through said electrolyte and for making anodic contact, said guiding and contacting means comprising a plurality of rolls having axle shafts in said compartment arranged to support the preformed structural member as it passes through said compartment, a cathode member of elongated form having an inner surface shaped to correspond to the contour of the surface of said structural member, said cathode member supported upon said axle shafts and formed to partially surround said structural member and the upper portions of said anode rolls, and insulating material between the cathode member and said axle shafts.

June 19, 1945

Hot Galvanizing

U. S. #2,378,458. S. C. Avallone, assignor to The American Steel & Wire Co. The method which comprises coating ferrous metal stock with a layer of copper, passing such copper-coated stock through a molten zinc galvanizing bath, said copper coating being effective to minimize the diffusion between the zinc and the ferrous metal stock at the normal temperature of said molten zinc galvanizing bath, and subjecting said stock to a mechanical cold working operation, effective to elongate it and alter its cross-sectional area.

Electrolytic Pickling

U. S. #2,378,761. F. Forsberg, assignor to The American Steel & Wire Co. In the art of electrolytically treating metal in a bath including molten sodium compound, the method comprising the use of a ferrous kettle for the bath and the inclusion of a nitrogen and oxygen containing compound by the bath having the characteristic of evolving nitrogen oxides at the anode when in an electrolytic circuit, in conjunction with passing the current from the kettle through the bath to the metal being treated in the latter, whereby the kettle is the anode, the current causing evolutions of nitrogen oxides at the surfaces of the kettle contacted by the bath, to prevent sludges from sticking to these surfaces and making cleaning of these surfaces by scraping a relatively simple proposition.

June 26, 1945

Electrolytic Polishing

U. S. #2,279,066. I. C. Clingen, assignor to Rustless Iron and Steel Corp. The method of polishing chrome-nickel stainless iron and steel by anodic treatment comprising immersing the metal to be treated in a bath containing 60% to 90% by weight of concentrated sulphuric acid and the remainder water, and passing direct current through the bath of a density of 6 to 12 amperes per square inch of the treated metal surface for such period of time as to prevent gray etching of the treated metal and to polish it while using the metal as the anode and while maintaining the bath at a temperature of approximately 30° C. to 50° C.

July 10, 1945

Process for Producing Electrodeposits

U. S. #2,380,044. Raymond A. Hoffman assigned to E. I. du Pont de Nemours & Co. The electrodeposition of an adherent, abrasion-resistant cathode deposit of a molybdenum and oxygen compound at a current density of 1 to 15 amperes per sq. ft. from an aqueous acid bath containing boric acid, a soluble nickel compound and a soluble molybdenum compound, the amount of molybdenum as metal being from 7 to 150 grams per liter.

Method of Cleaning Ferrous Metal Articles

U. S. #2,380,284. James H. Young assigned by E. I. du Pont de Nemours & Co. Method of removing oxides from a ferrous metal article which consists of immersing the article in a fused bath of an eutectic mixture of alkali metal hydroxide and alkali metal cyanide temperature of such bath being below 600° C.

August 7, 1945

Composition for Cleaning Metal such as Aluminum and Magnesium

U. S. #2,381,124. Joseph F. Hart assigned to Kelite Products, Inc. A composition for cleaning aluminum or magnesium consisting of an aqueous solution containing sodium orthophosphate and silicates in the proportions of 3 mols of Na_2O per mol P_2O_5 and one mol of Na_2O per two mols of SiO_2.

Electrolytically Polishing Stainless Steel

U. S. #2,381,167. C. R. Horwedel and W. J. Resch assigned to American Steel &Wire Company of New Jersey. A stainless steel electrolytic polishing method comprising making the steel the anode in an electrolyte of one part by volume of a solution of 60% chromic acid and 40% water and two to four parts by volume of a water solution of acetic or formic acid the acetic acid being 99.8% acetic acid, the formic acid being 90%, balance being water at a current density of 150 to 350 amperes per sq. ft. and at a temperature below 90° F.

Process of Producing Protected Metal Articles

U. S. #2,381,778. James M. Schoonmaker, Jr., and Franklin Stockton assigned to Standard Steel Spring Co. The method of protecting a ferrous article against corrosion which consists in depositing a continuous coating of nickel of uniform thickness on the article, then applying to the nickel a coating of tin and then heating at a temperature above 350° F. and below the melting point of tin for a period of time sufficient to diffuse at least a portion of the tin into the nickel.

August 21, 1945

Contacts for Copper Oxide Rectifiers

U. S. #2,383,311. Carl Hein assigned to Westinghouse Electric Mfg. Co. Method of manufacturing copper oxide rectifiers which comprises heating a copper blank in contact with an oxidizing atmosphere at a temperature just below its melting point, cooling to room temperature, removing any cupric oxide formed on its surface, condensing a vaporized metal on a portion of the surface of the sublimed metal.

August 28, 1945

Burnish Gold

U. S. #2,383,704. Kermit Ballard assigned to E. I. du Pont de Nemours & Co. A burnish gold preparation which comprises metallic gold, metallic silver and powdered sulfur.

Electroplating

U. S. #2,383,798. Richard O. Hull assigned to E. I. du Pont de Nemours & Co. In a process for electrodeposition of cadmium from an aqueous cyanide-cadmium bath the step comprising deposition in the presence of an isoamketaldoresin and not substantially more than 0.5 gram per liter of a sulfonated vegetable oil.

Method of Depositing Copper and Baths for Use Therein

U. S. #2,383,895. Jesse Stareck and Frank Passal assigned to United Chromium, Inc. An aqueous bath for electrodepositing copper comprising essentially in solution 45 to 75 g/l of copper, 75 to 185 g/l of formate radicals and 20 to 30 g/l of ammonium radicals and having a pH value between 2 and 4.

FOR *Automatic* POLISHING AND BUFFING

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When work breeds worry . . . treat the ailment, not the symptom. Reduce work, and worry will vanish AUTOMATICALLY . . . which, incidentally, is an excellent prescription. We have reduced the hand work of polishing and buffing to the vanishing point and, if you're one of those individuals who listen to the worry bird . . . we'd like to tell you about it.

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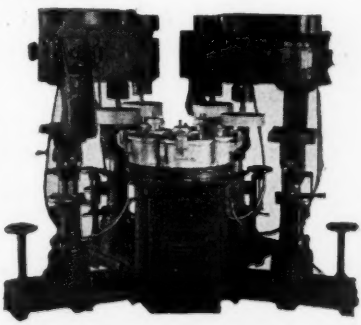

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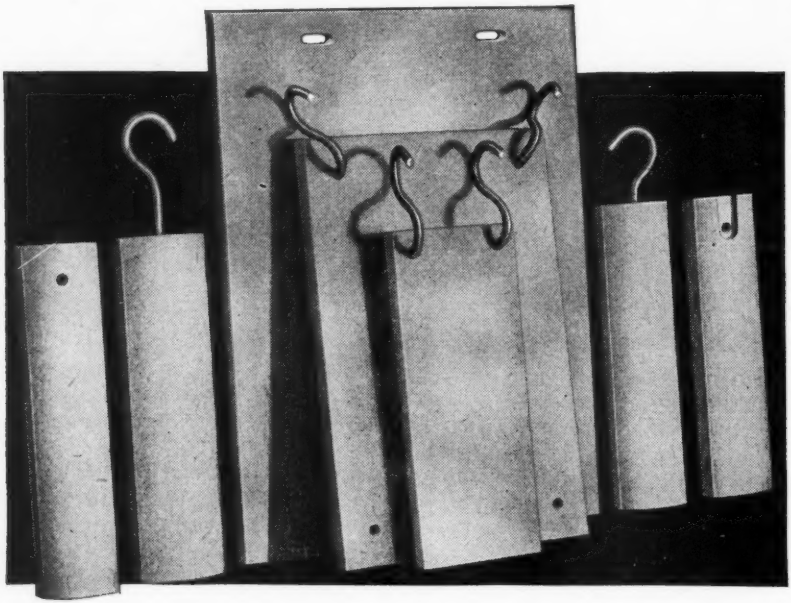

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An Investigation of Silver Plating of Steel

J. M. SPRAGUE. *J. Electrodepos. Tech. Soc.* **20**, 39-46, 1945.

For plating up to .002" of silver on steel, heating to 400°C (752°F.) for one hour and obtaining maximum adhesion, the following sequence of operations, after cleaning, was found to give best results: (1) Anodic etch in sulfuric acid solution (2) Rinse (3) Nickel Strike (4) Rinse (5) Acid Copper Plate (6) Rinse (7) Cyanide Dip (8) Silver Strike (9) Silver Plate (10) Rinse. All solution formulae and operating conditions are given.

L. B. SPERRY

The Lead and Allied Plating of Bearings

O. WRIGHT. *J. Electrodepos. Tech. Soc.*, **20**, 1-16, 1945.

The development of lead-tin plated and lead-indium plated bearings is reviewed and discussed. Plant practice at five English plants is given. A larger than usual amount of glue in a fluoborate lead solution (1/20 oz./gal.) also other organic matter, have a definitely detrimental effect. A current density of more than 12 amps./sq.ft. in this solution results in decreased bearing life. Methods of indium plating are discussed, methods of analysis of lead and indium plating solutions are given and methods of plate thickness control are provided.

L. B. SPERRY

High Speed Alkaline Tin Plating

MARTIN M. STERNFELS and FREDERICK A. LOWENTHEIM; *Metal Finishing*, February and March, 1945.

A review of tin plating. The alkaline sodium stannate bath has one principal limitation, lack of good cathode efficiencies at high current densities. Solubility of sodium stannate is relatively low and decreases as the temperature is raised, and is lowered still more by the presence of sodium hydroxide. Potassium stannate is considerably more soluble than sodium stannate. As the temperature is increased, more of the potassium salt will go into solution. An extensive investigation has shown that the potassium bath is 25% more conductive than the sodium bath, reflected in a 20% greater current flow without increase in voltage in a practical installation. The cathode efficiency is improved even in the conventional operating range by substituting potassium for sodium. In the more concentrated solution, these efficiencies are much more markedly superior. With respect to anode efficiency the potassium stannate bath shows no particular advantage over the sodium stannate bath. In either case it is generally possible by proper choice of operating conditions to ensure sufficient anode corrosion to keep the bath balanced.

R. B. KINNAMAN

A High pH Indium Cyanide Bath

J. B. MOHLER, *Metal Finishing*, February 1945, pp. 60, 77.

Addition of caustic to an indium electroplating solution favors bath stability as in a cyanide zinc bath. A suggested formula and the operating conditions recommended for the high pH indium bath are: indium 15-30 g./L., potassium cyanide 140-160 g./L., potassium hydroxide 30-40 g./L., dextrose 20-30 g./L., c. d. 15-30/sq.ft., temperature - room, steel anodes. The plate is white whether deposited from a new or an old solution.

R. B. KINNAMAN

Electroplating on Wire

JOHN KRONSBEIN and ALAN SMART. *J. Electrodepos. Tech. Soc.* **20**, 31-38, 1945.

Detailed description, with photographs, of a machine developed for the electroplating of wire, requiring only a small space for a great length of wire. The wire is run to the bottom of each tank on pulleys made of insulating material and thence to a circular assembly of rollers with vertical axes. Two of these are stainless steel and the rest are of insulating material. All are power driven by a gear assembly at the top, above the solution. The wire travels around the roller assembly in the form of a helix, the turns being spaced by "combs" made from glass rods. These roller assemblies are fixed installations, the tanks being raised to effect immersion. Details of operation, including subsequent baking for relief of hydrogen embrittlement are discussed.

L. B. SPERRY

Corrosion of Steels in Marine Atmospheres and in Sea Water

C. P. LARRABEE. *Electrochemical Society*, Preprint ***87-12*** for release April 16, 1945.

Data are presented to show that the amount of corrosion of unprotected steels exposed to the atmosphere depends upon the temperature, moisture content and gaseous and solid contaminants of the atmosphere and the composition of the steel. Corrosion in sea water is governed by a multiplicity of factors not easily reproduced and varies with local conditions. A very high alloy content is necessary for good resistance. Zinc coated steel products are highly satisfactory under many conditions.

FRANK K. SAVAGE, LEONARD WEEG

Electrography Applied to the Examination of Electrodeposits

H. D. HUGHES. *J. Electrodepos. Tech. Soc.*, **20**, 17-30, 1945.

Descriptions and illustrations of apparatus and methods used in electrography are given. When the method is used to identify a metal a carbon cathode rod is applied to the impregnated paper on the surface of the anodically connected metal to give an electrolytic spot test; a table detailing tests for nearly all of the commonly plated metals is given. A more important use is the testing of electrodeposits for freedom from porosity; methods and reagents for various metals are given; it is suggested that this method renders the well-known ferricyanide test more certain and also gives a test for porosity of coatings on brass. The possibilities of electrographic analysis are discussed, as is also the application of this method to the detection of impurities in electrodeposits.

L. B. SPERRY

Adjustable Anode Rack Aids Plating

Iron Age, **155**, No. 9, March 1, 1945.

Use of an adjustable insulated rod from which anode baskets are suspended permits rapid adjustment of anode-cathode distances to suit size and shape of the product being plated.

C. W. SMITH

Plating of Die Castings on Full Automatic Conveyor

H. A. SCHOONOVER. *Metal Finishing*, **43**, 287 (1945).

Blow by blow description of the encounter between L. H. Butcher and Die Cast Plating. Thirty-two well placed steps and the die was cast. Plating was automatically licked.

R. B. KINNAMAN

HAVING TANK TROUBLES?

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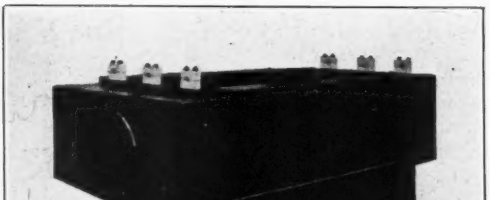

Every process has its points

EQUIPMENT requirements change as plating procedures change, and Storts keeps abreast of the times, always prepared to help in selecting the best tank designs and tank materials for plating cycles. Sometimes a standard design can be modified easily to meet new conditions. In other cases complete new designs pay their cost in time savings. With a background of twenty years of experience in this specialty, Storts is well prepared to assist in your reconversion.

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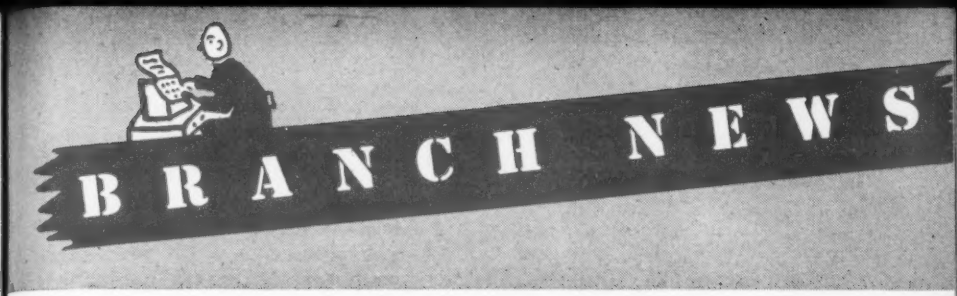


BUFFALO BRANCH

The following officers were elected at the June meeting to serve during the year 1945-46:

President — Seibert M. Johnson, 75 Seibert St., Jamestown, N. Y.

Vice-President — Dr. C. J. Wernlund, 8433 West Rivershore Drive, Niagara Falls, N. Y.

Secretary — J. A. Kushner, 316 Winslow Ave., Buffalo 11, N. Y.

Treasurer — Frank Nowakowski, 58 Wheelock St., Buffalo, N. Y.

Librarian — Bert Kirchhoff, 40 Prospect St., Jamestown, N. Y.

J. C. MAYS, *Secretary*

CHICAGO BRANCH

The Chicago Branch held its regular monthly meeting at the Hamilton Hotel on September 14. President P. Krause called the meeting to order at 8:00 P.M. with all officers present.

After the regular business had been taken care of the Librarian, Mr. C. W. Carter, introduced Mr. R. O. Olsen who talked on "Microblast Finishing." He was assisted by Mr. E. E. Hawinson of the Metal Finishing Service, a member of Chicago Branch. The speaker in his very interesting talk gave a good description of the process and covered many applications. Samples showing different metals and uses were passed around for inspection by the members.

The following questions were discussed: Q. 1: What acid is used in the patent on black chromium plating producing a deposit of 75% chromium and 25% oxide? — A. Acetic. Q. 2: How can staining of copper plated steel stampings be eliminated? — A. Use a 2% solution of potassium dichromate for the final hot rinse.

There were 94 in attendance and the meeting adjourned at 10:00 P.M.

M. H. LONGFIELD, *Secretary*

COLUMBUS BRANCH

The Columbus Branch, A.E.S., held its regular meeting at Battelle Memorial Institute on Friday, July 27, 1945. The meeting was called to order by our Librarian, Tom F. Lavery, at 8:00 P.M.

During the business session all pertinent information regarding the Society was read. It was decided to hold a basket lunch picnic at the Columbus Police Pistol Range on August 25. The commitee for arrangements consists of William J. Balzer, William J. Neill, and Leon L. Haas.

A symposium on Zinc Plating was then held in which two speakers, both members of this society, participated.

Mr. William H. Safranek, formerly with the Apollo Metal Works of Chicago and now associated with Battelle Memorial Institute, summarized an article of his "Specification Zinc Plating on Steel Sheets," which appeared in the June 1945 issue of the MONTHLY REVIEW.

Mr. William J. Neill, of the Columbus Metal Products Co. presented a condensation of his paper, "Discussion of Zinc Electroplating," and showed several samples of zinc deposits.

A question and answer session followed: Q. 1: Does cadmium cause trouble in crude zinc oxide? — A. No, it can be precipitated out with sodium sulfide.

Q. 2: In zinc plating did anode to cathode distance vary in the tanks? — A. Yes, from 3 to 10 inches, on the average 6 inches. Depends on the article being plated.

Q. 3: Does pyrophosphate zinc bath introduce embrittlement of spring steel stock? — A. There is evidence to believe that it does.

Q. 4: How do you figure 100% anode efficiency in an anodic cyanide cleaning solution? — A. If there is no gassing, 100% efficiency can be assumed.

Q. 5: Have you ever obtained black smutty deposits from a zinc bath after purifying it with sodium sulfide? — A. No.

The meeting was adjourned at 10:30 P.M.

DAVID S. STOKER, *Secretary*

COLUMBUS BRANCH

The Columbus Branch of the A.E.S. held a basket picnic at the Columbus Police Pistol Range at 5:00 P.M. on August 25, 1945. A shootin' good time was had by all. There were plenty of ice cream, orangeade, and OTHER refreshments.

Baseball and softball were played, but most of the time was taken up by target shooting. Wilson B. Green won the cup for hitting the bull's eye the greatest number of times, at least he shot the greatest number of times.

The feature of the evening was Lola Archer and the Buffalo gun. Three things happened: The target disappeared, the gun disappeared, and Lola disappeared. Miss Archer managed to get back for the basket lunch, however.

Everyone ate ice cream until — well, they ate ice cream.

Later in the evening you could even "Spit in the ocean."

Observed: Mrs. Cummins' beautiful potato salad. Frank Schladen's four aces. Leon Haas — target No. 13 and "the Sultan of Swat." The arsenal including the buffalo gun. Lefty Gomez Neill. Pistol Packing Balzer.

Thanks to William J. Balzer, Sergeant Grimm of the Columbus Police Force, Leon L. Haas and especially the wives of the members for making the picnic a great success.

DAVID S. STOKER, *Secretary*

PROVIDENCE-ATTLEBORO BRANCH

Providence-Attleboro Branch conducted its first meeting of the season Monday evening, September 17th in the Providence Biltmore Hotel. Over seventy-five members including some from Boston, New Haven, Bridgeport and New York Branches were present, as was one visitor from Pittsburgh.

The speaker for this occasion was Dr. Walter R. Meyer. His subject was, "Impurities in Electroplating Solutions." The lecture was illustrated by many interesting slides of deposits from impure solutions.

Judging by the comment and the applause at the finish of the lecture everyone in attendance was greatly pleased and very much appreciated this opening session.

Plans are being laid by the various committees in charge of the affairs of the Branch and we look forward to another year in which there will be a growth in membership and in Branch activities.

CHARLES C. CHACE, *Secretary*

DAYTON BRANCH

The August meeting of the Dayton Branch of the American Electroplaters' Society was held at the Engineers' Club. Fifty-two members were present.

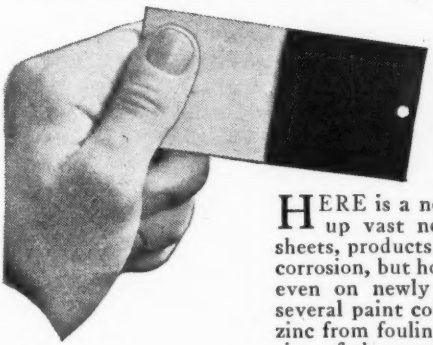
Mr. Luaces introduced Colonel H. A. Toulmin, Jr. as the speaker of the evening.

Presentation of the Toulmin Award. Left: W. E. Moline; Right: Col. Toulmin.

His subject was "American Business Goes to War." The story of how 29,000,000 men and 222,000,000 tons of war materiel were moved by rail after Pearl Harbor, and how an organization to carry out a billion-dollar ship and rail building program was developed from a nucleus of about five of-

(*Continued on page* 1049)

Adds Sales Appeal to Galvanized Sheets, Products, Parts



IRIDITE Shuts Out Corrosion, Provides Firm Paint Base, too

HERE is a new quick-dip process that opens up vast new fields of use for galvanized sheets, products and parts. Iridite not only balks corrosion, but holds paint or clear lacquer firmly, even on newly galvanized surfaces. Tests by several paint companies show that Iridite keeps zinc from fouling the paint . . . prevents formation of the soapy, chalky, underlying film that destroys adhesion. Galvanized products that have been Iridited take paint readily . . . hold it permanently.

Variety of Colors

For many uses, Iridite serves as an attractive final finish. It is available in a large selection of fast colors which do not vary. Included are blue, green, red, bronze, black and olive drab. Because of Iridite's excellent qualities as a paint base, all colors can be clear-lacquered for even greater durability, greater sales appeal.

Puts Crimp in Corrosion

Send for free test panel and see for yourself how Iridite bans corrosion on zinc die cast, zinc or cadmium plated or galvanized surfaces. Iridite goes on with a quick dip of 15 to 60 seconds, is dried in a few seconds, permits immediate handling and shipping. Send for your test panel today. Write Rheem Research Products, Inc., 14710 Standard Oil Building, St. Paul and Franklin Streets, Baltimore 2, Maryland.

3 WAYS TO BUILD PROFITS WITH IRIDITE

1 ***As a final finish,*** Iridite is available in a variety of attractive colors.

2 ***As a paint base,*** Iridite holds paint or clear lacquer firmly, even on newly galvanized surfaces.

3 ***To reduce costs,*** consider using galvanized, plus Iridite, in place of more expensive metals.

Test IRIDITE Yourself

RHEEM RESEARCH PRODUCTS, INC.
14710 Standard Oil Building
Baltimore 2, Maryland

Gentlemen: Please send me a free panel of Iridite-treated zinc plate for laboratory testing and full information and operating details.

Name.....

Company.....

Address.....

Mail Coupon for FREE Test Panel!

RHEEM RESEARCH PRODUCTS, INC.
IRIDITE
Standard Oil Bldg., Baltimore 2, Md.

Reg. U. S. Pat. Office

"A concentrated solution for the removal of heavy metal impurities from zinc plating solutions."

McKeon's

"Zinc-Brite"

TRADE MARK REG'D.

A concentrated solution guaranteed to completely remove heavy metal ions; such as copper, iron and cadmium which usually interfere with the operation of alkaline zinc plating solutions. The effect of "ZINC-BRITE" on copper ions is not quantative or complete in the presence of cyanide and varies with the concentration of the cyanide.

Its liquid form assures even dispersion throughout the plating solution — insuring complete and effective treatment.

It has the distinct advantage that filtration following precipitation is greatly simplified.

With its use the impurities are precipitated in such a condition that they will not mar the finish even when left in the plating solution.

WRITE! PHONE! WIRE COLLECT!

SULPHUR PRODUCTS COMPANY

GREENSBURG, PA.

BRANCH NEWS

(*Continued from page* 1046)

ficers and twenty-five civilians, was very interestingly presented.

For his part in this work Colonel Toulmin received the Legion of Merit.

After the address Colonel Toulmin presented the "Toulmin Award," founded by him in 1943, to Mr. Walter E. Moline for the paper he presented in January 1944 in the competition between the Ohio and Indiana regions during 1944.

A rising vote of thanks was given Colonel Toulmin for a very interesting evening.

RALPH L. CLINEFELTER, *Secretary*

LOS ANGELES BRANCH

The September meeting of the Los Angeles Branch was held Monday evening, September 10, at the Park Manor, 2200 W. 7th St., Los Angeles. Seventy guests and members were present.

Mr. G. E. Huenerfauth, President of Crown Rheostat and Supply Co., Chicago, gave a talk on "Plating Conditions Today." Mr. Huenerfauth made valuable comments on the equipment and supply situation.

Mr. Fred Maurer of the General Electric Company, Ontario, Calif., a member of the Los Angeles Branch, gave a talk on his army experience, and described some of the plants he had seen and the work they were doing. He also described and demonstrated the latest G.E. device for measuring the thickness of electrodeposited coatings on ferrous articles.

At the short business meeting the financial report was read and accepted. Communications were read and referred to the proper officers fro answer. Mac Munnell resigned, and his resignation was accepted with regret.

The matter of a new meeting place was left for decision by the officers.

FRANK BUNKER, *Secretary*

NEWARK BRANCH

The Question Box on June 15, 1945, contained the following:

Q. 1:What is the effect of brighteners on throwing power? — A. In cyanide and alkaline baths they increase the throwing power, where as in nickel and acid solutions they frequently decrease the throwing power.

Q. 2: Why is much greater voltage required for barrel plating than for still tank plating? — A. With the anodes outside the barrel, the barrel acts as a shield. Although the average current density on the surfaces of all the metal parts within the tank may be only 1/6 of the value for the same parts strung and plated in an open tank, those parts adjacent to the perforations no doubt receive rather high current density. Also, the metal content of the solution within the tank tends to become depleted which would increase the polarization. For best results the perforations in the barrel should be as large as possible, but in no case should the parts protrude through the perforations.

On July 20, 1945 the Question Box yielded the following:

Q. 1: Under what conditions can gold be plated .002″ thick? — A. In general, thick gold plating requires a clean solution, circulation of electrolyte, low current density and a long plating time. Other conditions are:

Gold content (metal) — 2 to 2½ Troy oz./gal.

Free cyanide (KCN) — 1½ to 2½ oz./gal.

Potassium hydroxide — not critical

Addition Agent — nickel cyanide ⅛ oz./gal. recommended

Temperature — 150° to 160°F.

Voltage — less than 1 volt with gold anodes

Anodes — gold or stainless steel or both. Circulation of electrolyte best achieved by moving cathode. Purification may be done either by the use of a separate settling tank or filtering. Continuous filtering is best. Tank of steel, glass lined.

Q. 2: What is a good method of preparing cast iron for plating? — A. Procedure suggested as follows: 1. Degrease. 2. Remove sand and scale with dilute hydrofluoric acid or sand blasting or tumbling with lump pumice. 3. Pickle in a mixture of sulphuric and nitric acids or with high reverse current in 50° Bé sulphuric acid. 4. Remove graphite smudge with soap emulsion cleaner, or by anodic alkali cleaning. 5. To plate chromium start with high current density (5 amp./sq. in.). 6. Tin is the best metal for a base coat on cast iron.

GEORGE WAGNER, *Secretary*

THE NUCLEUS OF THE ATOM

(*Continued from page* 999)

35.5. This anomaly has been completely explained by the discovery of the existence of "isotopes." Many elements consist of two or more forms which are virtually identical in their properties, but differ only in their atomic weights. Thus, chlorine consists of two isotopes whose atomic weights are 35.0 and 37.0, respectively. A mixture of these two in the proportion of three of the former to one of the latter gives the average atomic weight of 35.5, as actually found. The existence of isotopes can also be explained quite readily. The nuclei of the two (or more) isotopes of a given element contain the same number of protons, i.e., they carry the same number of positive charges, but different numbers of neutrons are present in each case. The nuclei of the two isotopes of chlorine each involve 17 protons (atomic number 17), but one contains in addition 18 neutrons (atomic weight 35), and the other 20 neutrons (atomic weight 37). It is the number of protons, i.e., the atomic number, which determines the chemical properties of an element, and that is why the properties of isotopes of the same element are almost identical. The total number of protons and neutrons determines the mass of the atom, but this is only of secondary importance.

With but twenty exceptions, all the known elements, as they occur in nature, consist of two or more isotopes. Some, such as hydrogen, helium, chlorine, etc., have two isotopes, while others have more; the element tin has ten stable isotopes, and probably others that are not stable. The factors which determine the number of isotopic forms in which a particular element can exist are however not well understood.

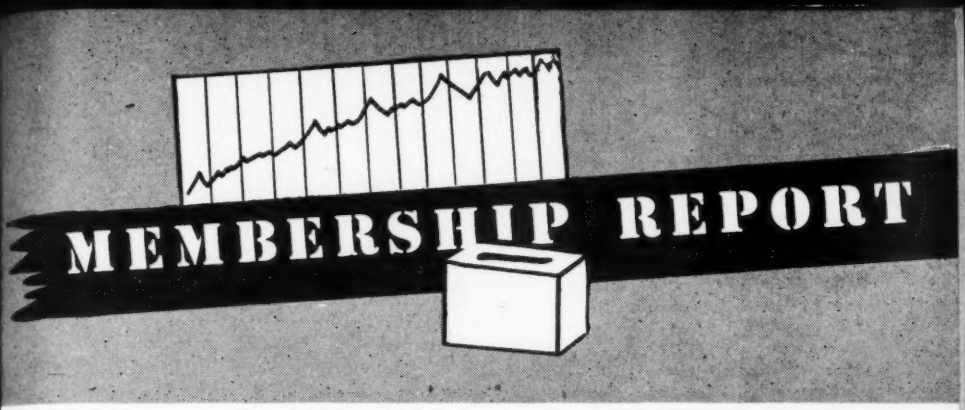
Wm. W. Wells

1882-1945

Wm. W. Wells, President of W. W. Wells, Ltd., died suddenly at his home in Toronto on the morning of Thursday, August 23. He was born 63 years ago on Manitoulin Island, Canada and at an early age moved to Toronto, where he received his education. He was a charter member of Toronto Branch A.E.S. and took an active interest in the work of the Society for some years after its inception and continued his membership up to the time of his death.

He was a Veteran of World War I, having served overseas with the R.F.C. For over forty years he had ben in the platers supply business founded by his father, managed it for the past ten years and was President of the firm since his fathers death on May 26, 1945. Burial took place in Mount Pleasant Cemetery on Monday, August 27 and was attended by a large number of the officers and members of Toronto Branch.

JOHN ACHESON
Toronto Branch



ELECTIONS

Boston Branch

Dominic Pungitore, 27 Cross St., Norwood, Mass.

Providence-Attleboro Branch

Henry A. Creeden, 5 County St., Attleboro, Mass.

Antone Oliver, 49 Lexington St., Attleboro, Mass.

Michael L. Nitso, 31 Emory St., Attleboro, Mass.

Cleveland Branch

Clarence R. Jordan, 3436 W. 10th St., Erie, Pa.

Robert E. Lamb, Cleveland Base Works, 1133 E. 152nd St., Cleveland, Ohio

Hartford Branch

Samuel Merman, Clairglow Mfg. Co., Portland, Conn.

Otto Schaefer, The Napier Co., Meriden, Conn.

Chicago Branch

Fred P. Heller, 130 Main St., Evanston, Ill.

Los Angeles Branch

Raymond M. Brummett, Oakite Products, 1001 E. 1st St., Los Angeles.

Bridgeport Branch

Kenneth J. Lamond, 355 Boothhill Rd., R.F.D. 18, Bridgeport, Conn.

Frederick L. Hintze, Harshaw Chemical Co., 420 Lexington Ave., New York, N. Y.

Carl Matkowski, 46 Waverly Place, Bridgeport, Conn.

Sydney Branch

R. J. Byatt, Amor Pty. Ltd., 1 Marshall St., Surry Hills, Sydney, Australia

G. W. Court, 42 Remley St., Lakemba, N.S.W., Australia

C. C. Dunn, 101 Dennison St., Camperdown, N.S.W., Australia

C. Freeman, Chrome Hardening Co., 29 Wyndham St., Alexandria, N.S.W., Australia

E. Fraser, 33 Pitt St., East Richmond, N.S.W., Australia

F. P. Heard, Standard Telephone & Cables, Ltd., Botany Rd., Alexandria, N.S.W., Australia

V. Smithers, 79 Blakesley Rd., Hurstville, N.S.W., Australia

J. Schiff, 11 Ritchard Ave., Googee, N.S.W., Australia

E. J. Wright, 29 Dewrang St., Lidcombe, N.S.W., Australia

R. N. Whale, Mandible St., Alexandria, N.S.W., Australia

R. Wade, 61 Hunter St., Bankstown, N.S.W., Australia

Columbus Branch

Harry M. Gould, 505 King Ave., Columbus, Ohio

APPLICATIONS

Dayton Branch

Albert O. Fink, 339 Claranna Ave., Dayton, Ohio

Kenneth C. Brown, 1771 Springfield St., Dayton, Ohio

Clarence J. King, 4021 Reading Rd., Dayton, Ohio

Malcolm D. Hire, 450 Oxford Ave., Dayton, Ohio

Earl L. Geiger, 223 S. Ludlow St., Dayton, Ohio

Arthur H. Horst, 2438 Catalpa Drive, Dayton, Ohio

Clifford H. Speck, 523 S. Market St., Troy, Ohio

Cleveland Branch

Joseph Gombos, 2523 E. 127th St., Cleveland, Ohio
Robert I. Klemm, 1106 Republic Bldg., Cleveland, Ohio
Fred G. Benditz, 2417 Tuxedo Ave., Parma, Ohio
Norman B. Dewees, 11610 Euclid Ave., Cleveland, Ohio
Carle E. Nesselroad, 9018 Empire Ave., Cleveland, Ohio

Columbus Branch

Harry M. Gould, 505 King Ave., Columbus, Ohio

Chicago Branch

John L. Mullen, 1729 C. St., Lincoln, Neb.
George W. Kindell, 3517 Cuming St., Omaha, Neb.

Hartford Branch

Harold F. Leahy, Rutland Electric Products Div., Rutland, Vt.

Newark Branch

Andrew J. Neafle, Quality Plating Co., Boonton, N. J.
Edward J. Gorczyca, 535 Myrtle St., Elizabeth, N. J.
Jean M. Verzier, 3 Highmount Rd., Great Kills, S.I., N.Y.
L. Busch, 259 Monticello St., Union, N. J.
Amos A. Bradd, 133 Chapin St., Binghamton, N. Y.
A. S. Santiago, 23 Thimmiah Rd., Bangalore, Cant., India

Baltimore-Washington Branch

John F. Simpson, c/o R. H. Bouligny, Inc., 403 W. Moreland St., Charlotte, N. C.
Joseph J. Cannizzaro, 3034 Strickland St., Baltimore 23, Md.
D. R. Bonner, c/o R. H. Bouligny, Inc., P.O. Box 2115, Charlotte, N. C.
Orville S. Smith, 2101 Chambrood Rd., Charlotte 2, N. C.

Providence-Attleboro Branch

Raoul V. Rioux, 75 Wilson St., Providence 7, R. I.
Gaetano A. Iacuzzi, 133 East St., No. Attleboro, Mass.
William E. Barton, 118 Union St., Attleboro, Mass.

TRANSFERS

Elmer Stephan, from Detroit Branch to Columbus Branch

RESIGNATIONS

Boston Branch
Edward E. Whitney

Providence-Attleboro Branch
G. Fred Lincoln

Detroit Branch
A. L. Spradlin
H. M. Foss
W. R. O'Neill
J. A. Maquire
D. S. Orcutt

Hartford Branch
John H. Totz
William Chaquette

SUSPENSIONS

Boston Branch
Fred D. Burney
James J. Grossbard

Providence-Attleboro Branch
Michael A. Bessacini

Detroit Branch
E. G. Sosnowski

Dayton Branch
Keith W. Nrtzley

REFERENDUM VOTE ON SUSTAINING MEMBERSHIP AMENDMENT

(*Continued from page* 997)

CEEDINGS. Sustaining Members shall *have no vote but* shall be entitled to receive copies of the MONTHLY REVIEW, Annual PROCEEDINGS and any literature pertaining to the advancement of the art of electroplating or allied arts issued by the Supreme Society."

Changes in the amendment as passed at the June meeting are italicized. It should be pointed out that other than changes in phraseology, the fundamental changes being voted upon involve the words "Executive Board" in the second sentence and the words "have no vote but" in the sixth sentence.

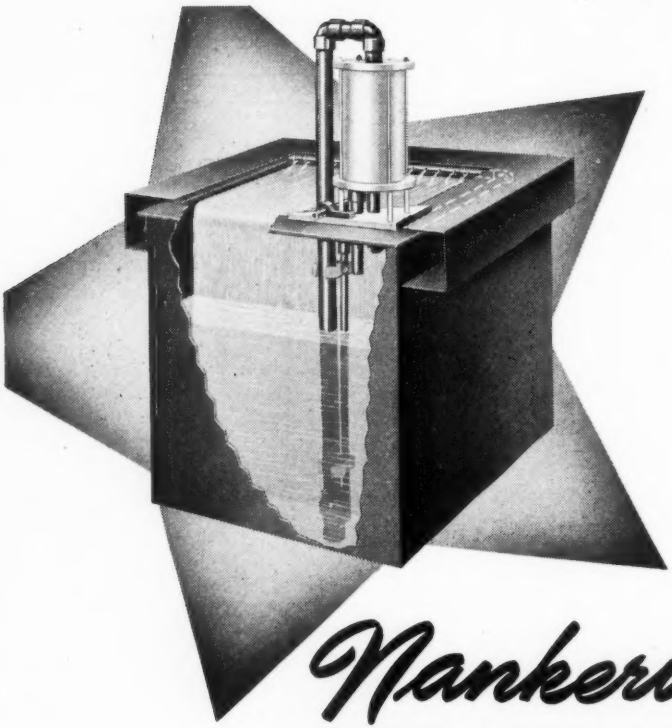
The delegates to the 1945 Annual Meeting will shortly receive from the Secretary's office their ballots from which must be returned not later than November 19 in order that the vote can be counted and reported in the MONTHLY REVIEW prior to January 1, 1946.

MEMBERSHIP CHART

BRANCH	May 1945	Change in Membership	Percent Change
FIRST GROUP			
PHILADELPHIA	154	+12	+ 7.8
CLEVELAND	143	+ 7	+ 4.9
BRIDGEPORT	118	+ 5	+ 4.2
CHICAGO	357	+13½	+ 3.8
LOS ANGELES	151	+ 4½	+ 3.0
NEWARK	213	+ 6	+ 2.8
NEW YORK	191	+ 3½	+ 1.8
GRAND RAPIDS	121	+ 2	+ 1.7
BOSTON	157	+ 2½	+ 1.6
BALTIMORE-WASH.	122	+ 1½	+ 1.2
DETROIT	390	+ 3½	+ 0.9
INDIANAPOLIS	112	+ 1	+ 0.9
WATERBURY	122	+ 1	+ 0.8
ST. LOUIS	116	—	—
TORONTO	119	— 1	— 0.8
HARTFORD	126	— 6	— 4.8
SECOND GROUP			
PROV.-ATTLEBORO	101	+ 6½	+ 6.4
ROCHESTER	90	+ 4½	+ 5.0
PITTSBURGH	80	+ 1½	+ 1.9
BUFFALO	89	+ 1	+ 1.1
NEW HAVEN	106	— ½	— 0.5
MILWAUKEE	107	— ½	— 0.5
DAYTON	109	— 6½	— 6.0
THIRD GROUP			
ROCKFORD	23	+14	+61.0
SYDNEY	51	+21	+41.2
TWIN CITY	52	+12½	+24.1
SAN FRANCISCO	55	+ 9½	+17.3
TOLEDO	54	+ 9	+16.7
SYRACUSE	57	+ 5	+ 8.8
LANCASTER	39	+ 2	+ 5.1
JACKSON-LANSING	62	+ 1	+ 1.6
SPRINGFIELD	73	+ ½	+ 0.7
CINCINNATI	57	—	—
MONTREAL	54	— 1	— 1.9

Membership May 1, 1945 = 3972
Membership Oct. 1, 1945 = 4153

Gain in Membership = 181
Per Cent of Gain = 4.6%



Nankervis
GIVES YOU A *Lift*

Again NANKERVIS beats the gun—this time with an acid lift that really fills the bill.

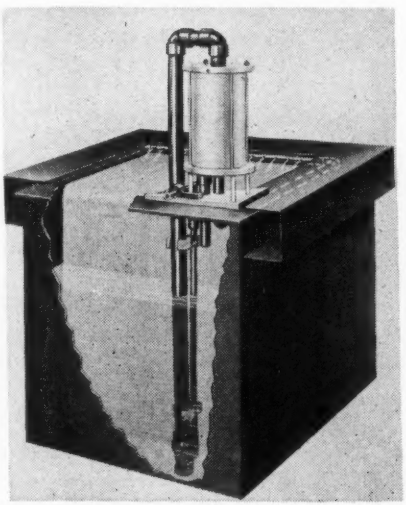
Light, sturdy, entirely constructed of saran and micarta with stainless fittings. No moving parts. Operated by six pounds air pressure. Easily installed on any acid dip tank with sump arrangement. Thoroughly efficient and dependable. Low operating cost. Maintenance nil.

Developed especially for continuous skimming of acid dip tanks to prevent oil fouling of automatically processed parts. Write for complete details and specifications.

GEORGE L. *Nankervis* COMPANY
5408 COMMONWEALTH AVE. ● DETROIT 8, MICHIGAN
COMPLETE METAL FINISHING EQUIPMENT

NEW Equipment Materials Supplies

Nankervis Develops New Acid Lift



The George L. Nankervis Company, 5408 Commonwealth, Detroit, have recently completed the development of a new acid lift for use in the continuous skimming of acid dip tanks. The new lift has no moving parts and is operated by six pounds air pressure. It is entirely built of corrosion resistant materials — Saran and Micarta pipe and cylinder with stainless attachments. The Nankervis Acid Lift keeps the solution clean, constantly and automatically, without necessity of shut-downs for skimming. A continuous dipping schedule may be maintained without danger of fouling with unskimmed grease and oils. The New Lift is light in weight, economical to operate, and is easily installed on any dip tank with sump arrangement. The company expects to be in production on this new device in a few weeks.

Aluminum Treating Process

Enthone Company, Dept. MR, 442 Elm St., New Haven, Conn., have announced a new process called the "Alumox" process for chemically treating aluminum and aluminum alloys that produces a corrosion-inhibiting coating that serves to protect the aluminum against corrosive atmospheres such as salt spray and also presents an excellent base for organic finishes.

The process is stated to be particularly suitable for non-copper containing aluminum alloys. On such alloys, coatings can be obtained with salt spray resistance of 250 or more hours.

The process requires no electric current and consists in immersing the aluminum in a dilute solution of "Alumox" salts operated near 210° F. from 2 to 15 minutes.

The finish obtained is grayish-green which is an attractive finish in itself. Further details are given in a booklet available on request.

New Popular Size Wash and Rinse Unit Announced By Optimus Equipment Co.

The new Optimue Single Stage Washer, which permits rinsing and washing in one unit, has been announced by Optimus Equipment Company, 131 Church St., Matawan, N. J., manufacturers of mechanical metal washing machines and dryers.

An additional feature is the fact that the unit is portable permitting it to be

easily spotted wherever the work is, eliminating the need of bringing the work to the machine. Another feature is the fact that the unit can be easily moved on to another spot as the flow of work eases on shifts from department to department.

The unit is small, compact, quick-working and handy, occupying a floor area of only 12 ft. Low in cost, unit comes complete with moving jets and easy-operating vertical sliding doors that adequately control splash and spray. Unit can be equipped with any type heating device and thermostatic control.

Peninsular Chemical Offers New Products

Peninsular Chemical Products Company, Van Dyke (Detroit), Mich., announces two new insulating products for plating plant use: Pen-Tape, an elastic, flexible masking tape for insulation of plating racks and masking of parts for selective plating; and Pen-Tube, for quick insulation of plating rack contact wires.

These materials it is said, effectively resist all plating and cleaning solutions and withstand rough handling and abrasion. They do not harden or crack under the severest service, but remain tough and flexible throughout long-continued use.

Pen-Tape's elasticity and flexibity allows very easily applications to irregular contours. It can be pulled out to more than twice its original length, giving unusual economy from the standpoint of coverage, and its elasticity and frictional properties hold it securely in place.

Made by a precision calendering process and not by extrusion. Pen-Tape is claimed to be uniformly thick and perfectly smooth throughout, assuring flat, leakproof overlap and minimum drag-out of solutions. It cannot stain or adhere to the work, is readily removed after plating, and the same piece can be used again and again. Regularly furnished in ¾" width for general-purpose use, Pen-Tape can also be supplied in any special width desired.

Pen-Tube is made of the same material as Pen-Tape but is tubular in form and is readily slipped into place. It is regularly available in sizes from 1/16" to 1" inside diameter, and other sizes can be furnished on application. All sizes are of the correct wall thickness.

Peninsular states that for rush jobs on plating racks, Pen-Tape and Pen-Tube can be applied by anyone and the racks used immediately. For permanent insulation of racks for production plating, these materials are fused into a smooth integral covering by heating at 260°F. for 20 minutes. Repairs become an integral part of the covering.

Full details on both of these new products are given in a bulletin available on request from Peninsular Chemical Products Company, 6795 East Nine Mile Road, Van Dyke, Mich. Ask for MR-2.

New Portable Industrial Washing Machine

The machine illustrated, manufactured by the "Industrial Washing Machine Corporation" of New Brunswick, N. J., is known as Model C.B.H.

The unit consists of a tank and housing and is portable. Mounted on the housing are electric immersion heaters, a pump and motor, valves, switches all wired, gauges, etc.

Parts to be cleaned are placed in a square mesh basket 16"x16"; cover is lowered, and the spray valve turned. The

force of the spray causes the basket to rotate so that all of the material is completely cleaned.

If desired, the basket can be removed and the machine is thus converted into a dip tank which can be used for wax or oil dipping of parts.

Advantages claimed for the C.B.H. machine are:

1. Portable construction.
2. Compact (3'x3' 6" overall)
3. Light weight (300 lbs.)
4. Enables parts to be cleaned in less than one minute
5. Designed to prevent detergents from coming in contact with operators' hands, thus eliminating dermatitis
6. Complete and thorough cleaning is assured

Unit can be used for cleaning stampings, ball bearings, castings, bakery pans, etc. Write for illustrated literature, MR-3.

MANUFACTURERS' LITERATURE

The following literature pieces are available to MONTHLY REVIEW readers upon request to the companies listed:

Automatic Plating Machine

Folder describes compact full automatic plating machine adaptable to 80% of all quantity plating jobs. Features counterbalanced hydraulic tank transfer control, versatile work carrier mechanism, standard replacement parts. Udylite Corporation, 1651 East Grand Blvd., Detroit 11, Mich.

Bright Nickel Plating

Bulletin No. 51 describes bright nickel plating process for protective and ornamental product coating. Lists plating applications, bath formulas, operating conditions, recommended voltages and amperages for successful plating. Udylite Corporation, 1651 East Grand Blvd., Detroit 11, Mich.

Buffs, Wheels, and Compositions

This 6-page folder illustrates the various types of buffs offered together with a concise recommendation of uses for each. Information also given for wheels and compositions. Udylie Corporation, 1651 East Grand Blvd., Detroit 11, Mich.

Engineering Design Development of X-ray Spectrometer

This 12-page Bulletin covers in detail the basic design principles involved in the Geiger-Counter X-ray Spectrometer — a recently developed industry control tool. Subjects discussed included X-ray diffraction principles, new instrument requirements, X-ray sources, pulse conditioning, frequency meter circuit, counting metal circuit, meters and controls, and applications. Amply illustrated with drawings and photos, this new Bulletin should be a valuable addition to the industrialists' library. North American Phillips Co., Inc., 100 E. 42nd St., New York 17, N. Y.

Coloring and Blackening Processes

An 8-page illustrated Bulletin describes the Enthone Ebonal processes for coloring copper and copper alloys and for blackening zinc and steel. Information is given on methods of application and uses. The Enthone Company, Dept. MR, New Haven 2, Conn.

Plating Processes Booklet

This 24-page booklet describes various electroplating processes offered by the manufacturer and gives for each, the type of solution employed and its preparation, type of deposits produced, operating conditions, equipment required and notes on applications. Processes covered include nickel, black nickel, cadmium, zinc, tin and lead, as well as the zinc-tin-copper bright alloy process. Hanson-Van Winkle-Munning Co., Matawan, N. J.

Machining and Finishing Magnesium Castings

With 4 of its 8 pages devoted to data on finishing magnesium alloy castings, this bulletin should be a useful reference for many platers and polishers. Outlined in tabular form are methods suggested for corrosion prevention, cleaning, chemical treatments, and polishing. Ask for Bulletin MR-1. Superior Bearing Bronze Co., 140 Banker St., Brooklyn 22, N. Y.

SPECIALLY TRAINED FOR AIR DUTY

UNICHROME*

AIR-DRY RACK COATING 203

For Today...and Tomorrow!

New and improved synthetic resins are one reason for the remarkable performance of Unichrome Air-Dry Rack Coating 203. Constant research in selecting and formulating these resins results in your getting *maximum* rack protection, at *minimum* recoating cost—and in a quick, easy way!

Dip your racks in the handy open-end drum. Drying is at room temperature. Your racks are thus thoroughly protected against the severest solutions and—many shops tell us—good for from 500 to 1000 plating cycles. Why not see for yourself with a trial order? Our nearest office will give you data and prices. Write now.

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Permanent Charter Award

The petition of the Columbus Branch of the American Electroplaters' Society for a permanent charter has been granted by the Executive Board at its meeting in New York on Friday, September 21, 1945. A charter for the Columbus Branch is now in preparation and arrangements have been made for First Vice-President Frank A. Savage to present this charter to the Columbus Branch at its regularly scheduled meeting on Friday, November 30.

The Columbus Branch has been so notified and further details will be published in the next issue of the REVIEW after the branch has completed its plans for this award.

CARE OF FIRE EXTINGUISHERS

(*Continued from page* 1030)

carbon dioxide cartridge, they should not be discharged for the annual servicing. Remove the head and gasket and inspect parts as outlined under the soda acid. Remove the cartridge and weigh on an accurate scale. A loss of half an ounce or more indicates leakage and a new cartridge should be inserted. If necessary, add water to bring the liquid in the tank up to the filling mark. Then replace the head.

Carbon Dioxide: Examine hose and horn for defects and see that the seal on the operating valve is intact. Weigh the unit. If there is a loss of weight, the extinguisher should be recharged. Recharging service is offered by the extinguisher manufacturer or his agents or by carbonic gas plants.

Pump Tank: Test by operating the pump several times, discharging the solution back into the extinguisher tank. A drop of thin lubricating oil may be placed on the piston rod packing. Bring up to the filling mark by adding water, if necessary.

Note on "A Case of Embrittlement of Steel"

Our friend, George B. Hogaboom, Sr., advises us that he instigated the investigation reported in the August issue of the REVIEW, and that credit should be given to H. S. Rawdon, Chief of the Metallurgy Division of the National Bureau of Standards, for carrying out the work.

Mr. Hogaboom presented this data at the symposium on Corrosion Cracking held jointly in Philadelphia, December 1944, by the American Institute of Mining and Metallurgical Engineers and the American Society for Testing Materials.

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(*Continued on next page*)

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(*Continued from preceding page*)

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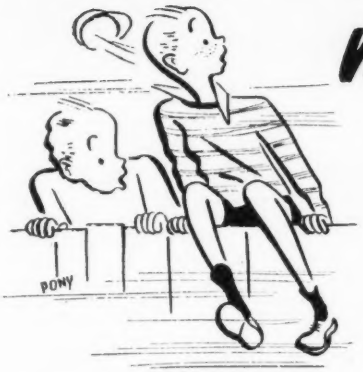

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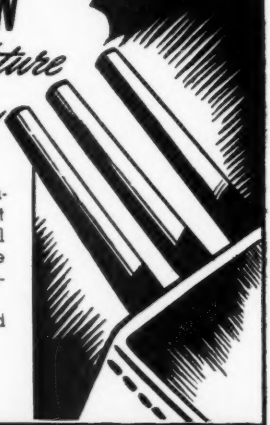

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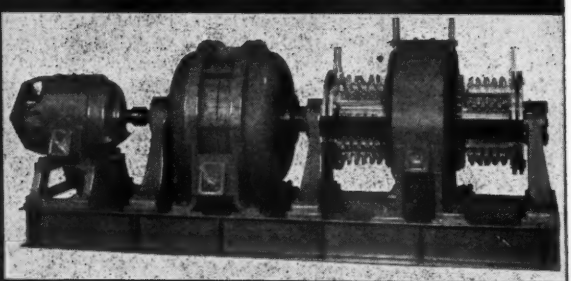

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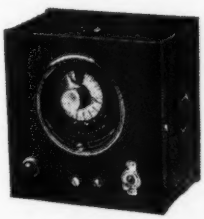

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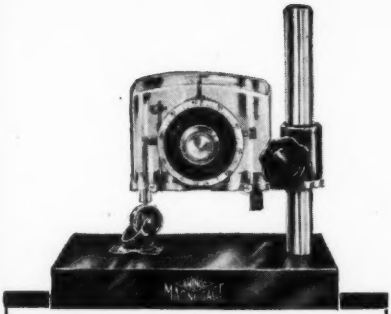

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INDEX TO ADVERTISERS

Alsop Engineering Company 976
American Brass Company 1040
American Chemical Paint Co. 984
American Instrument Co. 1067
Apothecaries Hall Co. 1064
Bacon Felt Company 974
Baker Company, M. E. 1059
Blakeslee & Co., G. S. 1063
Buckingham Products Co. 1066
The Ceilcote Company 1069
The Chemical Corp. 963
Codman Co., F. L. & J. C. 966
Columbia Electric Mfg. Co. 1064
Cowles Detergent Co. 986
Crane Equipment & Supply Co. 1068
Darco Corporation 988
Divine Brothers Co. 1068
Du Pont de Nemours & Co., Inc. 990
Duralac Chemical Corp. 998
Egyptian Lacquer Mfg. Co. 992
Enthone Company 962
Fidelity Chemical Co. 994
General Chemical Co. 1027
General Electric Co. 979
Gumm Chemical Co., Fred'k. Second cover
Hammond Machinery Builders 980
Hanson-Van Winkle-Munning Co. 1016-1017
Harrison & Company 1065
The Harshaw Chemical Co. 978
Hay Company, Jacob 1069
Heatbath Corporation 1067
Industrial Filter & Pump Co. 1036
Industrial Timer Corp. 1065
Kirk & Blum Mfg. Co. 1068
Kocour Company 1066
Lasalco, Inc. 996
Lea Mfg. Co. ..... Back cover
L'Hommedieu & Sons Co. 967
Maas & Waldstein Co. 1001
Mac Dermid, Inc. ... 1072 & Third cover
Magnus Chemical Co. 981
Magnuson Products Corp. 1068
The Manderscheid Co. 982
McAleer Mfg. Co. 1032
McGean Chemical Co. 968
Meaker Company 970
Michigan Buff Co. 1069
Mitchell-Bradford Chemical Co. ... 975
Nankervis Company 1054
Oakite Products, Inc. 961
Optimus Detergents Co. 972
Packer Machine Co. 1039
Pittsburgh Plate Glass Co. 1043
Promat Div., Poor & Co. 969
Puritan Mfg. Co. 973
Rheem Research Products, Inc. 1047
Seeley Company, E. E. 1069
Seymour Mfg. Co. 971
Sparkler Mfg. Co. 983
Standard Steel Spring Co. 1005
Stevens Co., Frederic B. 964
Storts Welding Co. 1044
Stutz Mfg. Co. 1063
Sulphur Products Co. 1048
Udylite Corp. 1070
United Chromium, Inc. 1058
U. S. Stoneware Co. 1031
Wyandotte Chemical Corp. 1060
Zapon Div., Atlas Powder Co. 977

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Don't take unnecessary chances with your finishing room production. Learn about the new individually formulated MAC DERMID INCORPORATED compounds that have been specifically developed for every metal cleaning, finishing, and stripping requirement . . . Our representative will be pleased to call, demonstrate, and prescribe the new faster acting, more positive MAC DERMID INCORPORATED compounds that have been developed for your particular need—show you through actual test how to secure a metallurgically clean basis metal in less time and at lower costs.

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MAC DERMID INCORPORATED chemists and Technical Service Engineers have at present perfected over 50 variations of METEX, ANODEX, and METALEX cleaners, strippers, and additives for the improvement of your metaling cleaning-finishing-plating cycle. Many of these compounds may mean the difference between success and failure in highly competitive post-war production.

Write for the new Revised Data Sheets Describing the Various MAC DERMID INCORPORATED Compounds Individually Formulated for Specific Needs

MAC DERMID

INCORPORATED

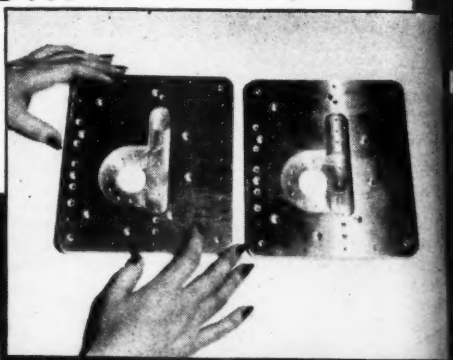
WATERBURY 88, CONNECTICUT

WRITE ONE OF THESE SERVICE ORGANIZATIONS FOR FREE DEMONSTRATION

NEW YORK | DETROIT | CHICAGO | CLEVELAND | ST. LOUIS | TORONTO—CAN.

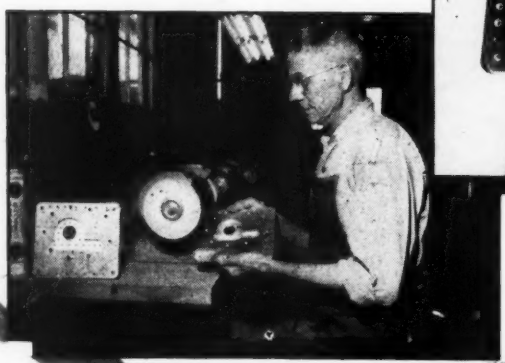
LEA Shows the Way

THE PIECES... *cast aluminum plates*



THE PLACE...

Pacific Gear Plant
Western Gear Works
Vernon, California



ARMY E NAVY

Here is a scene typical of those in countless plants where finishing operations are carried on. A bench, a wheel, Lea Compound or Learok and a skilled workman deburring, polishing or buffing a piece by a method devised with the help of the Lea Technical Staff.

Yes, the proper finishing of metals and non-metals calls for a thorough knowledge of the behavior of materials during the various finishing operations. It calls for the broadest experience in finishing . . . in burring, in polishing, in buffing.

It is here that LEA fits into the picture. We have the "greaseless" and "no free grease" compositions—lots of different grades, but it is on our technical service and sound recommendations that we have built and are maintaining our reputation as "Authorities on Finishing Operations."

THE LEA MANUFACTURING CO.

Waterbury 86, Connecticut

Burring, Buffing and Polishing . . . Manufacturers and Specialists in the Development of Production Methods and Compositions

NAVY